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Reichhold Chemicals, Inc, Tuscaloosa, Ala

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The waste effluent from operation of the Tuscaloosa, Alabama, plant of Reichhold Chemicals, Inc., results from both batch and continuous operations, contains both organic and inorganic wastes and varies both in composition and concentration. This report describes development of a bio-oxidation process which resulted in a significant reduction in BOD_5 and COD loading and almost complete removal of phenols. Lack of reliability ascribed to the bio process led to development of an activated carbon adsorption process that has resulted in the average removal of 90% of the COD, 75% of the BOD_5 and over 99% of the phenol load in the RCI process waste. Bio-oxidation should not be overlooked for treating industrial wastes although its usefulness is limited with respect to bacterial poisons, such as phenol, and by ambient temperature changes that result in variable biological activity.

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TREATMENT AND DISPOSAL OF COMPLEX INDUSTRIAL WASTES

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FOREWORD

When energy and material resources are extracted, processed, and used, these operations usually pollute our environment. The resultant air, land, solid waste and other pollutants may adversely impact our aesthetic and physical well-being. Protection of our environment requires that we recognize and understand the complex environmental impacts of these operations and that corrective approaches be applied.

The Industrial Environmental Research Laboratory - Cincinnati assesses the environmental, social and economic impacts of industrial and energy-related activities and identifies, evaluates, develops and demonstrates alternatives for the protection of the environment.

This report presents an investigation of alternate treatment systems for a complex organic industrial waste containing phenols. It describes the selection of carbon adsorption as the most dependable process for secondary treatment of this waste and details the evaluation of a full-scale installation treating some 500,000 gal/day of wastewater.

This project is one of several undertaken by IERL-Ci to establish that viable, economically acceptable technology does exist to treat industrial wastewater and protect our nation's waterways. This report will be of special value to the board segment of industry involved in designing treatment facilities for complex and, often, toxic industrial wastes as well as to the state and EPA officials responsible for establishing achievable standards for industrial discharges.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

The waste effluent resulting from operation of the Tuscaloosa, Alabama, plant of Reichhold Chemicals, Inc. may be considered typical of that from multiproduct chemical plants. The aqueous waste results from both batch and continuous operations, contain both organic and inorganic wastes and varies both in composition and concentration. This report describes development of a biological oxidation process which, when applied to the RCI waste, resulted in a significant reduction in BOD_5 loading, substantially complete removal of phenols and adequate reduction in COD loading. Lack of reliability ascribed to the biological process led to development of an activated carbon adsorption process that, when placed in commercial operation, resulted in the average removal of 90% of the COD load, 75% of the BOD_5 load and over 99% of the phenol load in the RCI process waste. Biological oxidation should not be overlooked for treating industrial wastes although its usefulness is limited with respect to bacterial poisons such as phenol and by ambient temperature changes that result in variable biological activity.

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SECTION I

CONCLUSIONS AND RECOMMENDATIONS

Both biological oxidation and carbon adsorption processes have been shown to be effective in reducing the pollution load in aqueous wastes generated by multi-product chemical plants as exemplified by the Tuscaloosa, Alabama, plant of Reichhold Chemicals, Inc.

Biological oxidation is more effective than adsorption in reducing the BOD_5 loading but is potentially less reliable. The biota upon which the bio process depends have been shown to be less effective as the ambient process temperature decreases in winter. Too, they have been shown to be sensitive to changes in the phenol concentration once they have been acclimated to a certain waste concentration level. A bio-oxidation process cannot be recommended for COD removal from industrial wastes if a significant part of the total COD load is due to sulfites or formates. It should also be noted that a bio process would be more easily adapted to the waste from "continuous" as opposed to batch-wise" processes.

A carbon adsorption-type process should be considered if the waste to be treated is variable in composition or concentration. An adsorption process will handle many refractory organic compounds that contribute to the COD load but are not susceptible to bio-oxidation. Indeed, carbon adsorption will handle wastes so refractory that they appear primarily in the TOC load. Carbon adsorption should not be considered if a substantial portion of the pollutant load consists of low-molecular weight organics. Organic compounds having a molecular weight below about 50 are poorly or not at all adsorbed by activated carbon.

It should be self-evident, but experience has shown that the results of laboratory investigations alone cannot safely be used as the basis for the design of an industrial waste-treating facility. Such a design should be based on parameters developed via sustained operation of a pilot or prototype treating plant being fed with a portion of the actual waste stream to ultimately be treated.

The data presented in Section VI and Appendix 2 clearly show that an Activated Carbon Adsorption Process is capable of significantly up grading the quality of industrial liquid wastes. As applied to the 0.5 MM gpd of RCI wastes the activated carbon process up grades them to meet the following EPA and AWIC discharge requirements.

Item	30-Day Daily Average	Daily Maximum	RCI Control*
BOD_5	1644 lbs	2300 lbs	390 ppm
COD	2672 lbs	3900 lbs	650 ppm
Phenol	27 lbs	27 lbs	6 ppm
SS	200 lbs	200 lbs	45 ppm
pH	Minimum - 6.0; Maximum - 9.0		

*value of item that is approximately equal to discharge limits for anticipated maximum waste flow.

SECTION II

INTRODUCTION

Liquid effluents from multiproduct chemical plants are frequently very complex mixtures. Treatment problems are accentuated if the waste results from batchwise as opposed to continuous types of chemical processes. The Tuscaloosa, Alabama, plant of Reichhold Chemicals, Inc. is a multiproduct operation employing many batchwise operations. The wastes from this plant are both complex in composition and variable in concentration.

While the work herein reported was performed, the RCI-Tuscaloosa plant was producing phenol (by the sulfonation process), sulfuric acid, pentaerythritol, ortho-phenylphenol, formaldehyde, a variety of urea- and phenol-formaldehyde resins, and alkyd resins. Operations at Tuscaloosa are largely batchwise.

The liquid waste or effluent from this plant consists of process spills, wash water resulting from cleanup of the plant and process vessels as well as certain aqueous waste process streams. From the data presented in Section III, entitled "Waste Sources and Characterization," it is obvious that this effluent would have to be treated in some manner if the discharge requirements of the U.S. Environmental Protection Agency and the Alabama Water Improvement Commission were to be met and a discharge permit obtained.

In September 1969, the Environmental Protection Agency in a joint effort with Geological Survey of Alabama and Reichhold Chemicals, Inc. granted funds to support in part Project Number 12020EGC entitled, "Treatment and Disposal of Complex Chemical Wastes." The scope of work of this project was subdivided into five general phases. Phase III and IV included but were not limited to the development and design of a suitable waste pre-treatment method for support of, or as an alternate to, a subsurface disposal well.

From early 1970 until early 1971, work on the problem of developing a waste-treating process was largely directed toward bio-oxidation as a method of reducing the BOD_5, COD and phenol loading in the waste to be finally discharged. Concurrently with the later stages of the bio-oxidation investigations, activated carbon adsorption was briefly investigated as tertiary waste treatment or polishing operation for the bio-treated waste if such were shown to be necessary.

Although the results of the biological oxidation of RCI wastes as presented in Section IV were satisfactory, a careful review of possible changes in RCI waste characteristics and possible ambient weather variations raised serious questions concerning the day-to-day reliability of the proposed bio-process. Accidental interruption to the steam (heat) supply to the bio-process during winter months (unlikely but not impossible) would result in partial to complete cessation of the biological processes with up to two weeks being required to regain the necessary level of biological activity. Too, it was shown that accidental or uncontrollable phenol spillage of as little as 1,000 pounds (improbable but not impossible) would cause complete loss of viable microorganisms and thus of biological activity. Thus, when, in early 1971, it was decided that bio-oxidation could not guarantee the necessary day-to-day reliability, work on carbon adsorption was resumed, this time as the basis for a total treating system.

Additional results of Phases III and IV are presented in this report in Section V entitled, "Carbon Adsorption Process." Section V presents the results of the laboratory and pilot plant work and the preliminary engineering work leading to the design of an activated carbon adsorption system for treating the RCI liquid waste.

Based on the data reported in Section V, a plant for treating RCI Tuscaloosa wastes was constructed and has been in essentially continuous operation since September 1973.

Section VI includes a description of the plant operation and a summary of plant performance.

SECTION III

WASTE SOURCES AND CHARACTERIZATION

For a better understanding of the direction of the reported work, a clear understanding of the makeup and composition of the RCI plant waste stream is desirable. An idea of the source and disposition of the various plant water streams may also be desirable.

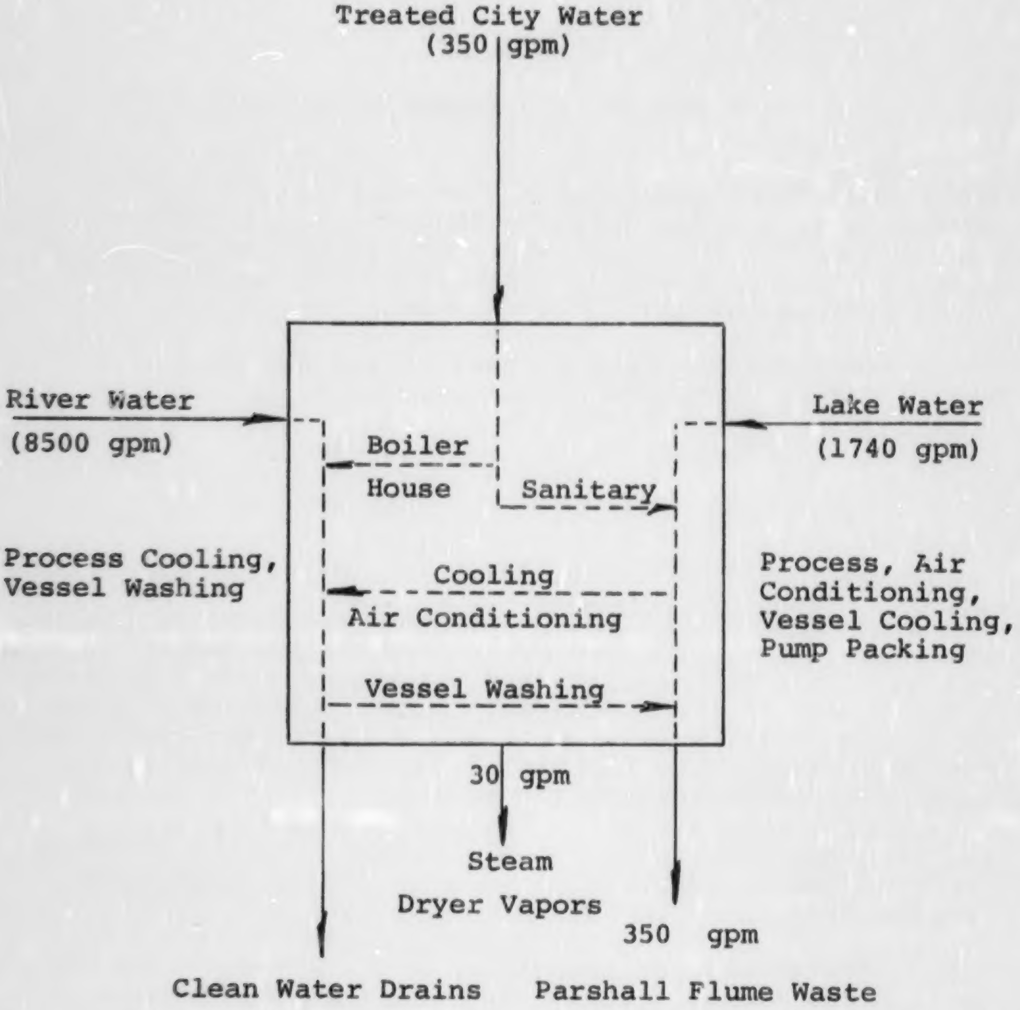
Water from three sources is used in the RCI plant. See Figure III-1. Approximate consumption rates are:

River Water	8500 gpm
Lake Water	1740 gpm
Treated City Water	350 gpm

Discharge from the RCI plant is also shown schematically in Figure III-1. Cooling water from various types surface and shell and tube coolers and condensers constitutes the major volume of the discharge. Makeup boiler water and water discharged from direct and indirect heat dryers are not considered. The balance of the water discharge results from process waste and equipment cleanup and amounts to approximately 350 gpm. This last discharge stream constitutes the plant waste to be treated. All of the work reported herein was done on spot or 24-hour composite samples from this stream.

The discharge stream, identified in Figure III-1 as "Parshall Flume Waste," had the following average composition for a period of typical RCI plant operations (see Table III-1). These data represent the average of 24-hour composite samples taken during the period January 29, 1971, to March 31, 1971.

The plant collecting system for this 350 gpm of waste is shown in Figure III-2.

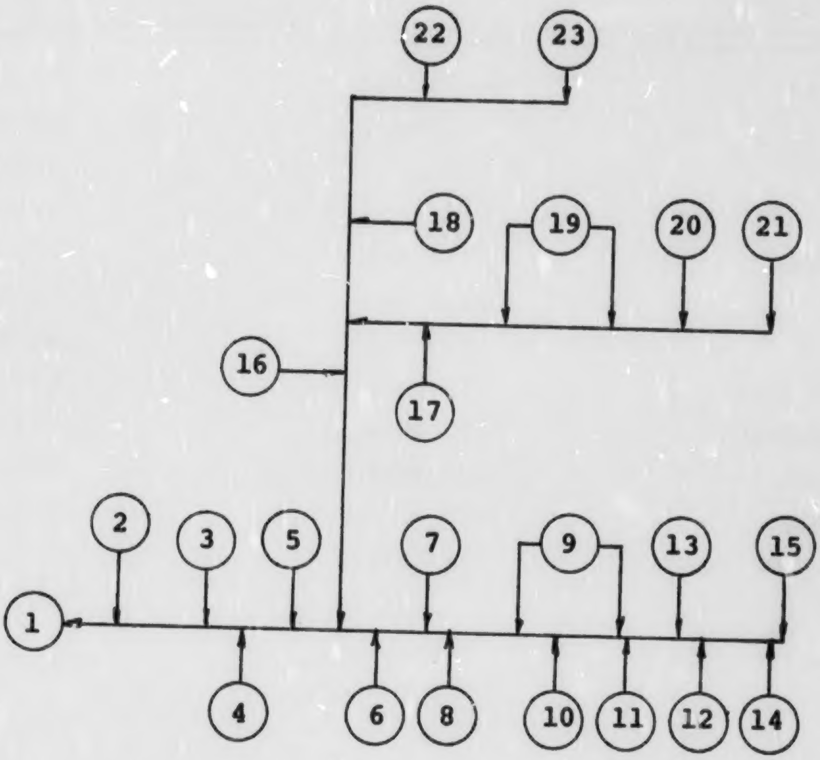

Treated City Water
(350 gpm)
River Water
(8500 gpm)
Lake Water
(1740 gpm)
Boiler
House
Sanitary
Process Cooling,
Vessel Washing
Cooling
Air Conditioning
Vessel Washing
Process, Air
Conditioning,
Vessel Cooling,
Pump Packing
30 gpm
Steam
Dryer Vapors
350 gpm
Clean Water Drains
Parshall Flume Waste

Note: Volumes given are those estimated for period February 25, 1971 - March 31, 1971.

Figure III-1. Source and discharge of RCI waste

Table III-1. RCI WASTE COMPOSITION
AVERAGE OF 24-HR COMPOSITE SAMPLES 1-29-71 TO 3-31-71

Flow	0.53 mgd	Average
DO	5.0 mg/l	Average
pH	10.8	Average
pH	5.5 - 12.3	Range
BOD_5	1643 mg/l	Average
DS	4600 mg/l	Average
COD	3773 mg/l	Average
Sulfite	235 ppm	Average
Sulfate	405 ppm	Average
Chloride	109 ppm	Average
Iron	0.5 - 2.0 ppm	Range
Phenol	420 ppm	Average



1	Parshall Flume
2	Technical Service
3	Technical Service
4	Shower Room
5	o-PP Plant
6	Maintenance Building
7	Resin Plant
8	Production, S & R Office, T/T Loading Area
9	PE Plant
10	Resin Storage Area
11	Formaldehyde Plant
12	Resin Storage Area
13	Alkyd Kettle
14	Solvent Tank Area
15	Drum Storage Area
16	Boiler Room
17	T/C Washing
18	West Tank Storage Area
19	Phenol Process Area
20	50% Caustic Concentration Area
21	Acid Plant
22	Phenol North Tank Area
23	Sulfonation Storage Area

Figure III-2. RCI waste collecting system

SECTION IV

BIOOXIDATION PROCESS DEVELOPMENT

DISCUSSION

A pilot or prototype biological oxidation waste treating plant operated at RCI, Tuscaloosa, for approximately eight months. This pilot plant has demonstrated that a biological oxidation process can effect a significant reduction in phenol, BOD_5, and COD content of the wastes emanating from the RCI operations.

Design and operating parameters for the biological oxidation process are presented that achieve a 99+% phenol removal, 97% BOD_5 removal, and 80% COD removal from the complex wastes from the RCI operations.

Although not necessarily applicable to every complex effluent, the data presented can certainly provide guidelines for application of the biological oxidation process to similar wastes from other multiproduct chemical operations.

Preliminary laboratory work indicated that a biological oxidation process should be capable of effecting a significant reduction in the phenol, BOD_5, and COD loading of the plant waste. A prototype or pilot treatment plant was assembled and operated in different modes and under varying conditions substantially continuously from July 30, 1970, to March 31, 1971.

Major design and process factors to be considered during pilot plant operations were limited to

(A) Need for primary clarification.

(B) Extent of waste equalization needed.

(C) Need for and extent of waste dilution.

(D) Need for and extent of waste neutralization.

(E) Need for and extent of waste nutrification.

(F) Type of biological oxidation, i.e., trickling filter or complete mix.

(G) Oxidation time, i.e., retention time in either or both types oxidation unit.

During the period February 25 to March 31, 1971, apparently satisfactory design and operating parameters were confirmed via thirty-five (35) days of sustained pilot plant operation. During this period, phenol removal averaged 99+%, BOD_5 removal 97%, and COD removal 82%.

PILOT PLANT LAYOUT

The pilot treating plant used to obtain the results reported in this section is shown schematically in Figure IV-1. The pilot plant was designed and built by Monsanto Biodize Systems of Great Neck, New York. The plant design was based on the available waste characterization given in Table IV-1, on a report entitled "Biological Waste Treatment" prepared for RCI in 1968 by the Center for Research in Water Resources of the University of Texas at Austin, Texas, and on the results of a preliminary survey by Monsanto Biodize personnel.

Primary System

Referring to Figure IV-1, the Parshall feed for the pilot plant was introduced by the feed pump P-1. The pump suction was located in the basin before the Parshall Flume about 8" - 12" below the surface. A mesh screen on the suction line was cleaned as needed. Severe operational difficulties were encountered with this pump. Because of the nature of the waste, it and the screen required frequent cleaning and maintenance.

The waste stream was pumped to a weir box on top of the equalization tank T-1. The flow could then proportioned according to the desired residence time in T-1. The excess flow was recycled to the area of this basin before the Parshall Flume.

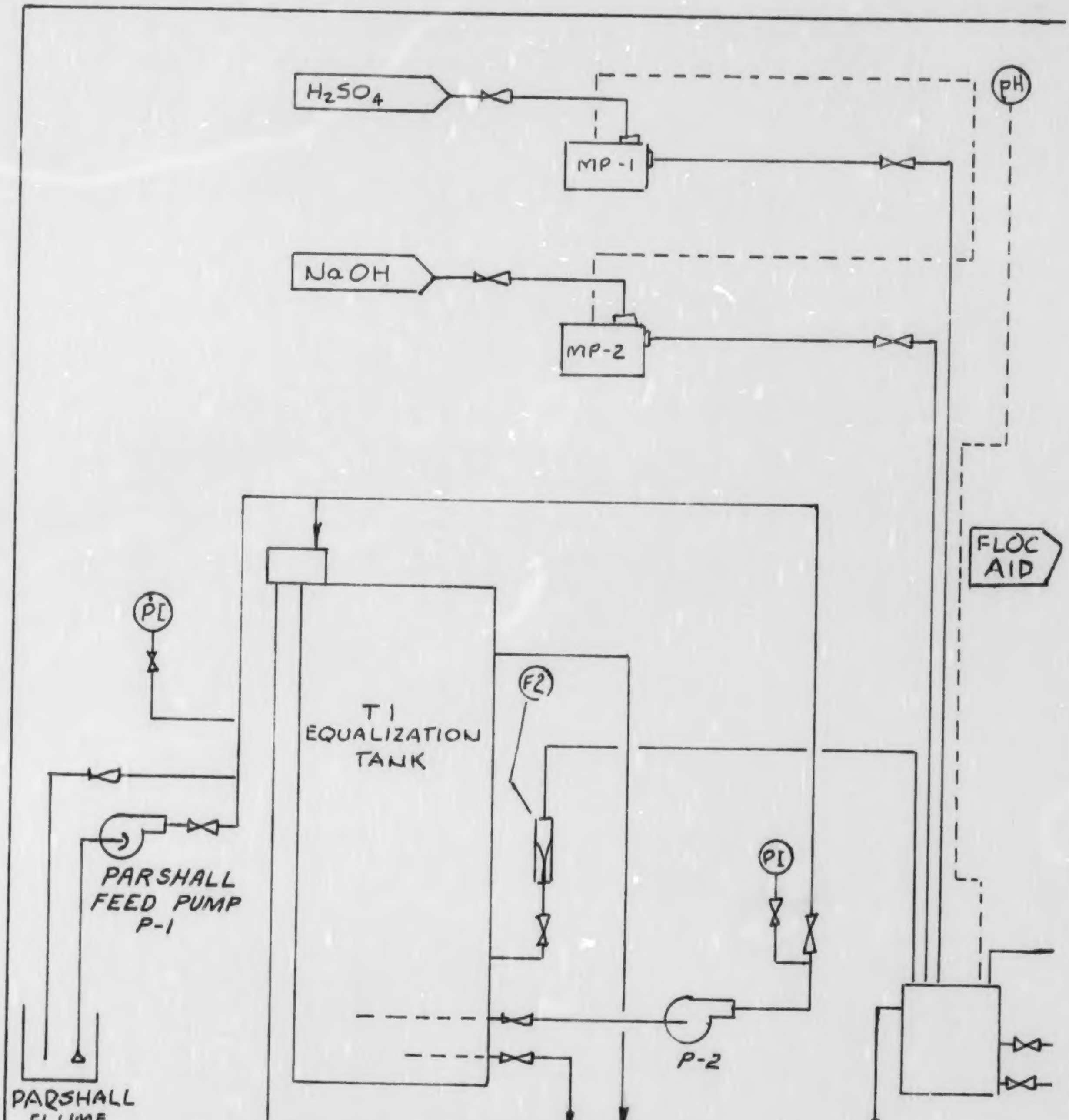
The equalization tank T-1 had a capacity of 9600 gallons. The contents of T-1 were mixed using centrifugal pump P-2 which had a suction line at the bottom of the tank and discharge at the water surface.

After equalization, the feed flowed to T-2, the agitated neutralization tank, which had a capacity of approximately 300 gallons.

Table IV-1. RCI WASTE WATER CHARACTERIZATION, BY SOURCE

Plant and effluent	# per batch	# per day	GPD	BOD_5 PPM	COD PPM	TS PPM	% VTS	SS PPM	% VSS	pH
ortho-Phenylphenol Plant										
*TP-51	44500	44500	---	66000	287880	333430	42	3340	60	3.4
TP-81	22000	5130	---	82500	83664	98650	28	95	0	0.9
Acid Wash Water	32000	8530	---	3810	10900	107285	32	100	50	0.5
Caustic Wash Water	31200	8320	---	14800	21115	31064	4	70	29	7.1
First Water Wash	30000	8000	---	8370	11450	85510	72	290	100	7.5
Second Water Wash	30000	8000	---	4640	5593	1522	23	50	90	7.5
Phenol Plant										
Sulfonation Scrubber	74000	44400	---	48000	86172	107260	21	200	0	10.3
Fusion Drains	---	---	1440	166	182	1184	23	135	0	7.4
W. Tank Farm Drains	---	---	4320	1300	2505	656	20	25	60	6.9
Pentaerythritol Plant										
#821 Barometric Cond.	---	---	288000	103	225	440	9	37	100	5.7
#822 Barometric Cond.	---	---	217000	206	300	584	31	145	14	6.9
*S2F-12 Waste	8320	9430	---	72700	646000	906220	52	103260	85	5.9
*SF6 Waste	500	540	---	70700	516000	863110	54	74420	100	5.9
Formaldehyde Plant										
Air Caustic Scrubber	4470	2240	---	79	366	18906	5	375	31	12.9
Resin Plant										
Phenolic B.O. Tank	55000	16500	---	10500	33066	37744	8	115	78	13.2
#705 Boil Out	170000	34800	---	315	1952	1646	92	55	64	7.2
Urea Blower	1000	140	---	1030	2505	41588	99	65	100	8.7
Alkyd Boil Out	60000	4000	---	20	5952	45650	8.8	590	65	13.2
St-82 Wash Out	80000	48000	---	330	4980	1350	81	30	100	7.5
Shipping and Receiving										
Truck Washing	---	9820	---	3337	30156	15990	39	---	---	9.7
Filter Washing	---	17870	---	3600	42660	27970	47	65	100	9.5

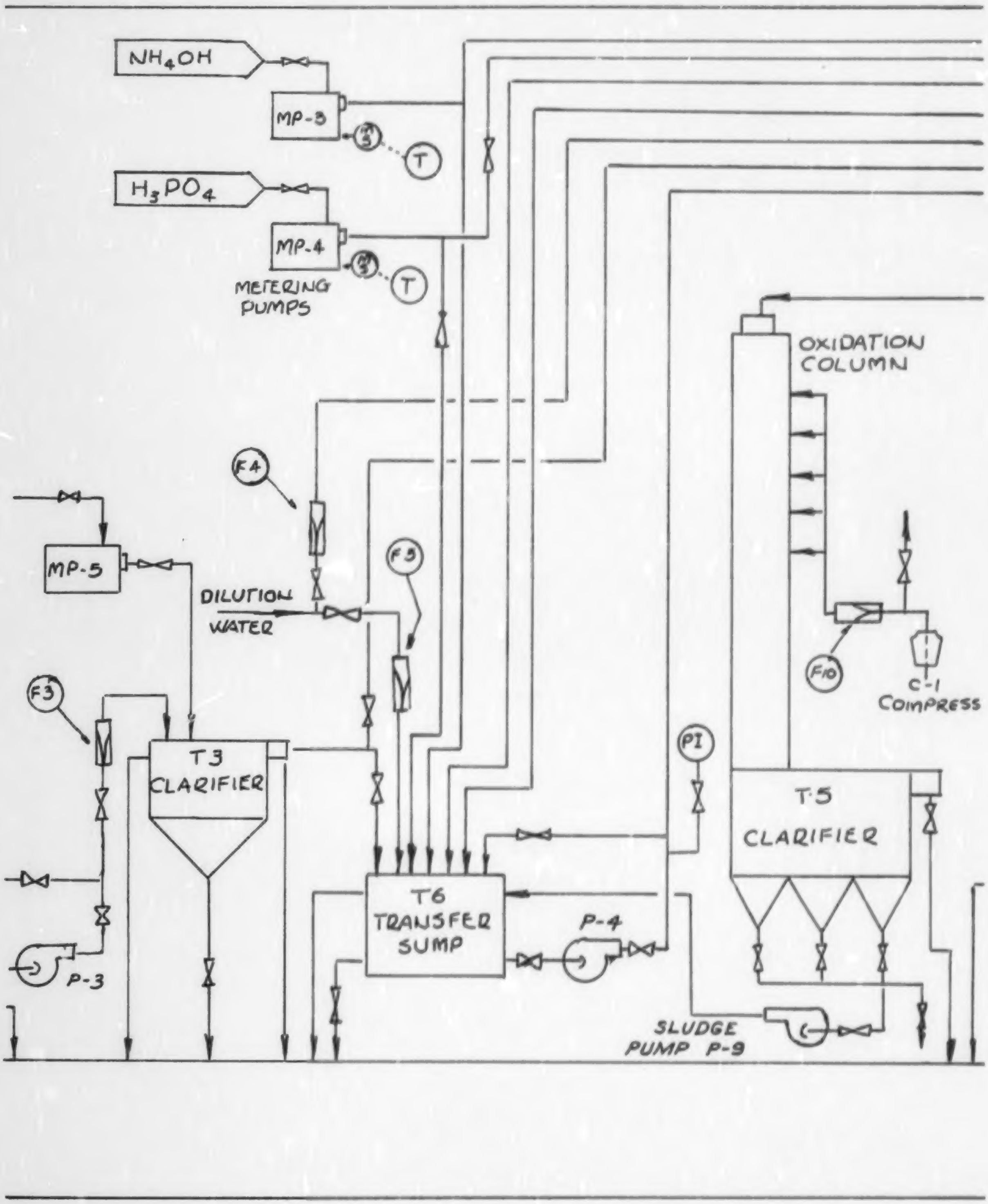
*Indicates streams segregated 1/29/71.



H_2SO_4
NaOH
MP-1
MP-2
pH
FLOC AID
PI
FI
T1 EQUALIZATION TANK
PARSHALL FEED PUMP P-1
PI
P-2
PARSHALL FLUME

The reader is urged to remove pages 13, 14 and 15 and tape them to 12 in sequence to form a "fold-out" diagram.

Figure IV-1.
Pilot waste treating facility


NH$_4$OH
MP-3
T
H$_3$PO$_4$
MP-4
T
METERING PUMPS
OXIDATION COLUMN
F4
F5
MP-5
DILUTION WATER
F3
T3 CLARIFIER
T6 TRANSFER SUMP
P-4
P-3
PI
T-5 CLARIFIER
F10
C-1 COMPRESS
SLUDGE PUMP P-9

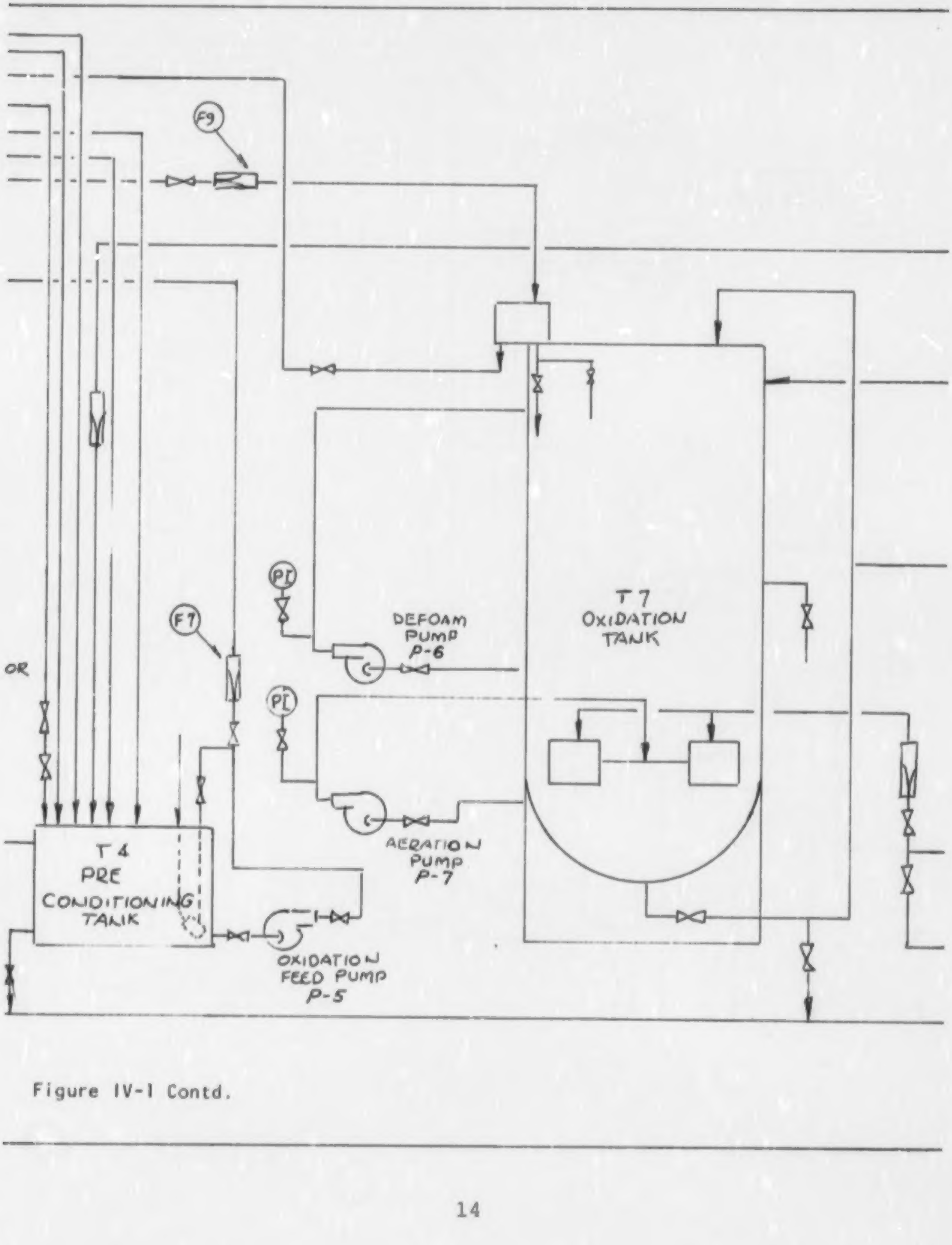
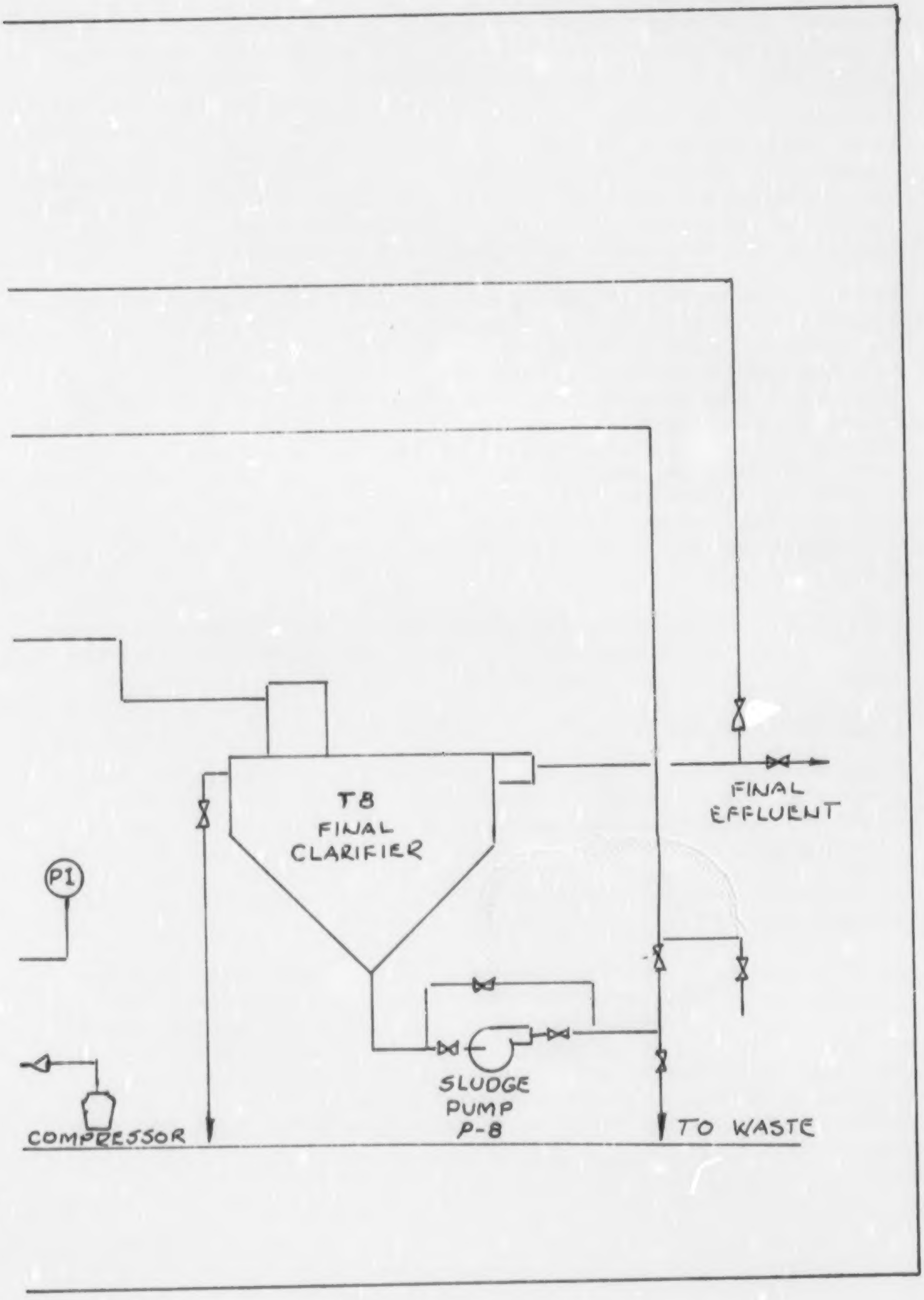

F9
OR
F7
PI
PI
DEFOAM PUMP P-6
T 7 OXIDATION TANK
T 4 PRE CONDITIONING TANK
AERATION PUMP P-7
OXIDATION FEED PUMP P-5

Figure IV-1 Contd.


T8
FINAL
CLARIFIER
PI
FINAL
EFFLUENT
SLUDGE
PUMP
P-8
COMPRESSOR
TO WASTE

Metering pumps were available to feed H_2SO_4 or NaOH as needed. The pumps were controlled on an on-off basis with a continuous recording pH meter and controller which was connected to on-off starter switches. The sensing electrodes were located in T-2 and the recorder-controller was located in the Control Laboratory. It soon became apparent that continuous pH adjustment would not be necessary because of a change in the waste stream from the Resin Plant. The pH recorder-controller unit was removed and small operational adjustments in pH were accomplished batchwise by addition of the agent directly to the reactor.

From the neutralization tank the waste was pumped to the primary clarifier T-3. This was a cone-bottomed tank 8' in diameter with a capacity of 2280 gallons. This tank was removed from the system when it became apparent that the basin before the Parshall Flume area, in conjunction with the placement of the suction line of P-1 and the mesh screen around it, was acting as the primary clarification step. Before removal of the tank T-3, the flow was proportioned by valves to T-4, the preconditioning tank, and T-6, the transfer sump, by gravity. After removal of T-3, T-2 was bypassed and the waste flowed from T-1 by gravity to T-6.

During the first and last portions of the study, nutrients in the form of 75% phosphoric acid and aqua ammonia were added to T-6 on a daily basis.

Activated Sludge System

From the transfer sump T-6 (760 gallons), the waste was pumped to the flow control weir on top of the aeration tank T-7. This oxidation tank reactor was a 4700-gallon, 8'-diameter vertical steel tank. The vessel was equipped with a diffused air aeration system. Air was supplied by an industrial blower. The air flow was measured with a rotameter.

An 8'-diameter, 2000-gallon clarifier, T-8, was used for separation of the biomass from the product water. The center well was 2' in diameter and extended approximately 5' below the water surface. The clarifier walls were scraped twice daily by a hand-operated scraping pole. Sludge return was accomplished initially by a variable speed Moyno pump. When this failed, a gear pump was substituted.

Clarifier T-8 was entirely adequate for clarification of the oxidation tank effluent through Development Period IV. It did not, however, provide a desirably clear effluent during Periods V and VI when the balance of the pilot plant was producing effluent that met the project's stated objectives. Correction of this deficiency in T-8 would have necessitated its removal and design and installation of a completely new clarifier. Adequate data (settling test; SVI; oxidation tank feed rates; SS, final effluent; SS, mixed liquor) are included in the raw data tabulation to permit design of an adequate clarifier based on T-8. For these reasons no consideration was given to replacing T-8 as part of this project.

Oxidation Column System

Six 3'-deep plastic packed sections for biological growth were a part of the column. The sections were 2' x 2' x 3' and were spaced vertically one foot apart. Air injection ports were located between each two packed sections and a forced draft was supplied by a blower. The amount of air could be varied to each port. Glass observation ports were located above each packed section for observation of slime build-up and sampling.

A 750-gallon capacity collection tank T-4, with an aspirator, was used as a preconditioning tank before feed was sent to the tower. During periods with recycle, the tank allowed mixing of the raw feed with the tower effluent. A two-way clarifier, T-5, was directly under the oxidation column. Solids were removed from the clarifier by use of sludge pump P-9. During tower start-up, solids from T-5 were recirculated back to T-4.

OPERATING PRINCIPLES

Primary System Equalization

Although most operational periods of this work were conducted with twenty-four (24) hours' equalization time, three (3) days' equalization time would be recommended for any similar work because of the extremely wide variations in the characteristics of the waste. The one-day equalization time was a result of the hydraulic limitations of the pilot plant equipment. A three-day retention time on a commercial plant scale will prevent extreme variations in organic loadings, as well as provide better equalization of the slug discharges of various organic and inorganic materials that should be anticipated in the waste from batch-type operations similar to those comprising the RCI-Tuscaloosa operations.

Primary System, pH Control

The biological process operates most effectively over the range pH 6-8. This refers to the pH of the mixed liquor in contact with the biological growths and not the pH of the waste entering the system. The Parshall waste is diluted by the aeration tank contents and is neutralized by reaction with the CO_2 produced by microbial respiration. Oxidation of organic acids also results in the production of CO_2 adding to the buffering capacity of the system. It was established early in the course of this work that no pH control would be needed and practically no pH adjustment. The period of most favorable operation of the unit required no pH control of any kind.

Primary System, Nutrification

On-site operations during start-up were begun with the addition of nitrogen (N) and phosphorus (P) in the form of aqua ammonia and 75% phosphoric acid, to the oxidation tank feed or the oxidation column feed. This practice was a result of the preliminary waste characterizations which indicated that the waste contained little, if any, phosphorus or nitrogen. Nutrients were added in the ratio of BOD_5:N:P/100:5:1. After several weeks of operation, severe problems with secondary clarification arose. A green slime growth in the clarifier, floating sludge and high solids in the effluent called for a reevaluation of the nutrient requirements. Reexamination of the waste seemed to indicate sufficient nutrients in the waste and the addition of supplemental nutrients to the pilot plant feed was stopped. During the latter part of this work, a check of analyses and a reevaluation of some aspects of the waste characterization by consultants disclosed a severe nutrient deficiency. Additions of P and N in the aforementioned proportions were reinstated for the final operational periods of this work.

Secondary System, Biological Concepts

For stabilization of organic matter in an aerobic environment, the basic reaction is Organic matter + O_2 + $NH_3 \xrightarrow{\text{cells}}$ new cells + CO_2 + H_2O. Auto oxidation follows cellular synthesis and may be expressed by the following reaction:

$$\text{Cells} + O_2 \rightarrow CO_2 + H_2O + NH_3 + \text{inorganic cellular particles}$$

In the first equation, soluble organic matter is converted into insoluble cells. These cells have a higher specific gravity than the carrier liquid and therefore can be separated by gravity sedimentation.

In a completely mixed activated sludge system, the effluent concentration is equal to the level of soluble substrate remaining in the bio-reactor. With longer retention times (lower loadings F/M), the declining growth phase is entered in which the reaction represented by the second equation is occurring to a greater extent. Some cellular material is metabolized because of increased energy requirements and this leads to a lower solids production.

Secondary System, Activated Sludge

The complete mix activated sludge process, in which all organisms returned to the bio-reactor from the clarifer are fully acclimated, has found extensive use in industrial waste treatment applications because of the mixing and buffering effect of the aeration tank which tends to level out variations in the waste loadings. The effluent can be kept at a very high quality and solids production held to a minimum.

Secondary System, Trickling Filter

Trickling filters consist of beds of crushed stone, aggregate or plastic packing over which the waste water flows. A microbial film (slime layer) which develops on the surface of the packing is responsible for removal of organic matter from solution, along with the stripping effect of surrounding air. As the waste water trickles over the bed, both dissolved and suspended organic matter are removed by adsorption. A portion of the adsorbed materials is absorbed into the slime layer and oxidized by the organisms and a certain amount is carried off as part of the solid mass scoured off as the slime layer grows. Solids are separated from the effluent by gravity sedimentation.

Secondary System, Staged Oxidation

This treatment scheme is exemplified by the combination of two or more distinct processes in series, i.e., a trickling filter before an activated sludge system. A review of the literature concerning high phenolic CPI wastes (especially that concerning the Dow Chemical Company waste treatment plant at Midland, Michigan) indicated that the prototype waste treatment facility should be flexible enough for this type of investigation. The use of trickling filters by many municipal waste treating systems led us to believe that the action of a trickling filter ahead of the complete mix oxidation tank might have a beneficial effect. This did not prove to be the case during this work and the trickling filter did not prove an adequate substitute for equalization or to reduce retention time in the activated sludge unit.

Secondary System, Air Requirements

Although of ultimate importance, data on the precise air requirement for the process development was not one of the stated objectives of this work. Regardless of the basis employed (cubic feet of air per gallon of waste treated or cubic feet of air per gallon of vessel capacity), the actual air flow required to maintain any desired level of DO will be a function of the type of air distribution used for a full-size treating plant and the geometry of the treating vessels. Lacking this information, no attempt was made to accurately record plant air flows. (Adjustments in air flow, either direct or indirect, to the oxidation units were made to keep the DO content of the mixed liquor or the final plant effluent as close as possible to the optimum value of 5 ppm.)

Temperature Control

Temperature variations can affect all biological processes. Biological reaction rates usually increase to a maximum at some optimum temperature. Initially no provision was included in the pilot plant set-up for adjustment or control of the temperature of the mixed liquor in the oxidation tank. As can be seen from selected data plotted in Figure IV-2, we experienced a distinct downward trend in both BOD_5 and COD removals achieved in the oxidation tank until a small heat exchanger was installed for the third developmental period.

The optimum temperature for biological processes will probably vary with the nature of the overall process; for the specific process being developed at RCI a temperature of 75 - 85° F seems optimum.

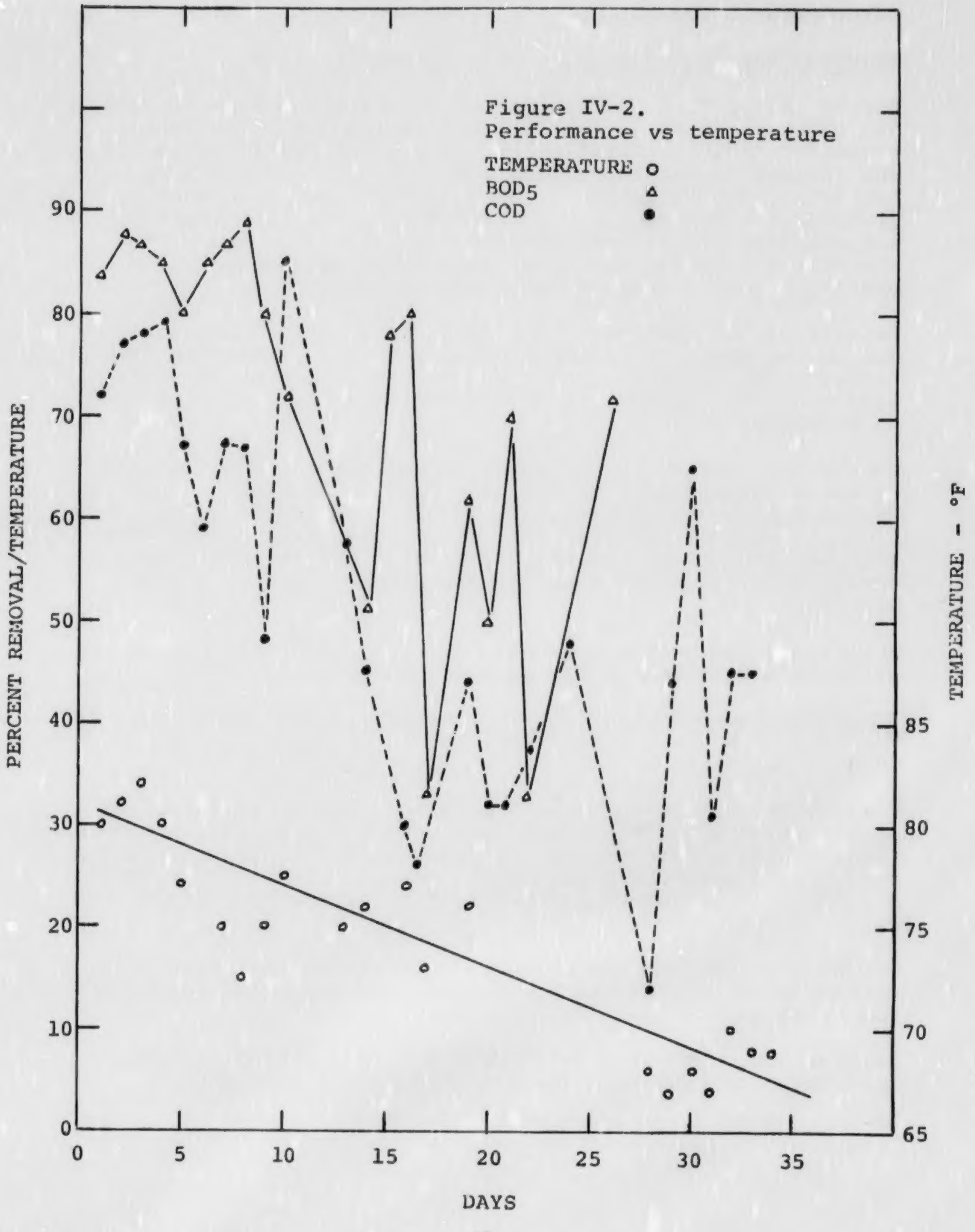


Figure IV-2.
Performance vs temperature

DEVELOPMENTAL OPERATIONS

Start-up Period, July 30, 1970 - August 31, 1970

During this period the system was filled with Parshall feed and checked out mechanically. All instruments were calibrated or their calibration rechecked. Sludge formation in the biological oxidation tank seemed to proceed normally. Bacteria acclimatization as evidenced by phenol removal proceeded to the point that a reasonably complete sampling and analysis program was started July 30, 1970, and continued until August 31, 1970. The first developmental operation period started September 1, 1970.

Details of the mechanical and operational adjustments made during the start-up period are not believed germane to this report since different pilot plants and each type of waste feed would be expected to pose a different set of problems to be worked out.

During this period it was established that the combination of waste equalization in T-1 (see Fig. IV-1) plus the buffering capacity of the oxidation tank T-7 rendered continuous pH control unnecessary. It was also established that the position of the Parshall feed inlet and the protective screen over the inlet rendered the primary settler T-3 unnecessary.

Analytical and performance data are not summarized but are given in the tables of raw data in the Appendix.

First Developmental Period, September 1, 1970 - September 10, 1970

Towards the end of the Start-up Period, the operation of the entire pilot plant had stabilized to the degree that a complete sampling and analysis program was instituted to acquire performance data for a particular set of operating parameters. A summary of operating parameters and performance results are given in Table IV-2.

During this period, the primary clarifier T-3 was by-passed, automatic pH control was not needed, and the oxidation tower was by-passed.

Examination of the tabulated data for this period indicates that the oxidation tank loading (F/M ratio) was high,

Table IV-2. DEVELOPMENTAL PERIOD I SUMMARY

Average Flow, Parshall Flume	0.4 MGD
Equalization Time T-1	24 Hrs.
Retention Time T-7	24 Hrs.
Dilution Ratio	2:1
Sludge Recycle	46%
Organic Loading, F/M Ratio	0.43
pH, Equalized Feed	8.5
pH, Effluent	7.7
DO Uptake, T-7	14 Mg/l/hr.

	Average, PPM	Range, PPM
MLSS	2216	1360 - 2860
BOD_5, Equalized Feed	2013	1400 - 3100
BOD_5, Effluent	357	308 - 435
BOD_5, Reduction	82%	12 - 49
COD, Equalized Feed	5120	3540 - 6760
COD, Effluent	1118	694 - 1285
COD, Reduction	78%	---
Phenol Reduction	98 - 99%	---
TS, Equalized Feed	6100	4102 - 9336
VTS, Equalized Feed	1340	---
SS, Equalized Feed	119	15 - 350
VSS, Equalized Feed	79	---
DS, Equalized Feed	5960	3990 - 9276
TS, Effluent	2240	2128 - 2400
VTS, Effluent	470	---
SS, Effluent	84	16 - 280
VSS, Effluent	50	---
DS, Effluent	2140	---

average 0.43; the solids in the oxidation tank remained low; the DO uptake was erratic and performance of the oxidation tank was poor. Phenol removal was in the 98 - 99% range.

First Interim Period, September 11, 1970 - September 23, 1970

Because of the poor performance of the oxidation tank by itself during the First Developmental Period, it was considered desirable to investigate the effect of the oxidation tower operated in series with the oxidation tank.

The oxidation tower was filled September 10, 1970, and operations started at a low rate using a 1:1 feed dilution. Slime development on the packing appeared normal and some reduction in BOD_5 and COD occurred. The tower unit operation appeared to have leveled out; consequently the Second Developmental Period for the entire pilot plant was started September 24, 1970.

The analytical and performance data for this interim period are not summarized but are given in the table of raw data in the Appendix.

Second Developmental Period, September 24, 1970 - September 30, 1970

During this period the oxidation tower was operated in series with and feeding the oxidation tank. A summary of the operating parameters and performance results is tabulated in Table IV-3. Performance of the oxidation tower did not improve as expected. Oxidation tank loading decreased; an average F/M value of 0.22 was maintained. Overall system improvement in both BOD_5 and COD removal versus the first period was achieved. Phenol removal efficiencies of 99+% were obtained. Lack of sufficient improvement in performance coupled with believed somewhat erratic performance led to termination of this second period of process development operations.

Second Interim Period, October 1, 1970 - November 19, 1970

Pilot plant operating performance continued to be erratic and generally poor during this period.

It was considered that the Parshall feed to the equalization tank might contain bacteriologically toxic materials

Table IV-3. DEVELOPMENTAL PERIOD II SUMMARY

Average Flow, Parshall Flume		0.55 MGD
Equalization Time, T-1		24 Hrs.
Retention Time, T-7		48 Hrs.
Dilution Ratio		2:1
Sludge Recycle	100%	
Organic Loading, F/M Ratio		0.22
pH, Equalized Feed		11.0
pH, Effluent		7.9
DO Uptake, T-7		21 Mg/l/hr.

	Average, PPM	Range, PPM
MLSS	3015	2200 - 3920
BOD_5, Equalized Feed	3443	2020 - 4935
BOD_5, Effluent	137	100 - 198
BOD_5, Reduction	84%	---
COD, Equalized Feed	7177	4340 - 8850
COD, Effluent	657	430 - 832
COD, Reduction	71%	---
Phenol Reduction	99+%	---
TS, Equalized Feed	9620	7260 - 11737
VTS, Equalized Feed	2040	---
SS, Equalized Feed	131	32 - 225
VSS, Equalized Feed	66	---
DS, Equalized Feed	9520	7235 - 11584
TS, Effluent	2185	1996 - 2380
VTS, Effluent	350	---
SS, Effluent	85	20 - 205
VSS, Effluent	36	---
DS, Effluent	2130	---

other than phenol whose effect had not shown up during the preliminary laboratory studies or that had not been present in the waste used for the preliminary studies. Evaluation of samples from the process via Warburg respirometry did not indicate that bacterial poisoning was a factor. The very poor and erratic performance of the oxidation tower during the Second Developmental Period led to careful physical examination of the tower and microscopic examination of the biota. The tower was mechanically in good operating condition. Although the gross slime growth on the packing appeared to be satisfactory, the anaerobic layer seemed to be thicker than normal for the usual trickling filter-type operations. Microscopic examination of the biota showed a preponderance of wormlike forms; more importantly, resinous-appearing material seemed to coat the slime layer almost completely. This observation is probably the cause of the poor tower performance. The coating on the slime results in poor contact between the slime and the liquid waste. The coating could be expected to have such a low diffusion rate that the complex substrate requires a much longer contact time with the active (slime) layer than a trickling filter-type of process can provide. For this reason the oxidation tower was cut out of the system November 11, 1970.

Third Developmental Period, November 20, 1970 - December 8, 1970

For operations during Developmental Period III, the oxidation tower had been by-passed during the Second Interim Period. Because of a change in the Parshall feed concentration - addition of cooling water from a barometric-type condenser - no artificial dilution was needed. Sludge recycle was set at 100% to raise the F/M (loading) factor to 0.5. There was still no positive indication of the need for supplemental nutrients, hence none were added. Sludge content of the oxidation tank increased as the period progressed. Ambient and oxidation tank temperatures, which had started to drop during the Second Interim Period, continued to do so. Supplemental heating was resorted to (small heat exchanger on the oxidation tank recycle line) in order to maintain the oxidation tank temperature in the favorable range of 75 - 85°F.

Performance of the pilot plant was somewhat more consistent than during previous periods but, because of increased oxidation tank loading, the percentage reduction in BOD_5

and COD actually dropped versus Developmental Period II. Phenol removal remained at 99+%. Data for this period are summarized in Table IV-4.

Fourth Developmental Period, December 10, 1970 - December 20, 1970

This Developmental Period IV followed Period III with the only change being an increase in oxidation tank retention time from twenty-four to thirty-six hours. Data for this period are presented in Table IV-5. Despite the increased retention time, there was no increase in BOD_5 reduction while the COD reduction actually dropped marginally.

Third Interim Period, December 21, 1970 - January 7, 1971

The pilot plant was, in a practical manner, shut down but not unloaded for this period since Reichhold operations were drastically curtailed over the period of the Christmas holidays. Parshall feed for the pilot plant was either non-existent or not typical.

Fourth Interim Period, January 8, 1971 - January 29, 1971

This period of operation was divided into a series of short runs wherein the retention time in the oxidation tank was varied from 72, 192, 120, and back to 192 hours. Each individual "run" was prolonged to give at least one "turnover" of the tank contents. Performance was mediocre. Data from these periods are available in the tables of raw data in the Appendix.

During the Fourth Interim Period, the RCI waste was reexamined and reanalyzed and was found to be seriously deficient in available N and P nutrients. Further, careful examination of all operating data suggested that performance of the oxidation tank improved somewhat when the flow of certain specific waste streams from the RCI plant was low or non-existent for short periods of time.

Fifth Developmental Period, January 30, 1971 - February 24, 1971

On January 29, feed of three specific waste streams (see Table IV-1) was diverted from the main RCI waste stream that provided the Parshall feed to the pilot plant.

Table IV-4. DEVELOPMENTAL PERIOD III SUMMARY

Average Flow, Parshall Flume	1.76 MGD
Equalization Time, T-1	24 Hrs.
Retention Time, T-7	24 Hrs.
Dilution Ratio	None
Sludge Recycle	100%
Organic Loading, F/M Ratio	0.5
pH, Equalized Feed	9.8
pH, Effluent	7.8
DO Uptake, T-7	23 Mg/l/hr.

	Average, PPM	Range, PPM
MLSS	3915	1500 - 6400
BOD$_5$, Equalized Feed	1341	855 - 2410
BOD$_5$, Effluent	345	150 - 535
BOD$_5$, Reduction	74%	---
COD, Equalized Feed	3217	2130 - 5060
COD, Effluent	1220	670 - 1750
COD, Reduction	61%	---
Phenol Reduction	99+%	---
TS, Equalized Feed	3410	2540 - 5312
VTS, Equalized Feed	89	---
SS, Equalized Feed	134	25 - 285
VSS, Equalized Feed	86	---
DS, Equalized Feed	3290	2425 - 5266
TS, Effluent	2540	2234 - 3414
VTS, Effluent	559	---
SS, Effluent	87	10 - 265
VSS, Effluent	53	---
DO, Effluent	2460	2062 - 3364

Table IV-5. DEVELOPMENTAL PERIOD IV SUMMARY

Average Flow, Parshall Flume	1.33 MGD
Equalization Time, T-1	24 Hrs.
Retention Time, T-7	36 Hrs.
Dilution Ratio	None
Sludge Recycle	100%
Organic Loading, F/M Ratio	0.24
pH, Equalized Feed	7.9
pH, Effluent	6.6
DO Uptake, T-7	34 Mg/l/hr.

	Average, PPM	Range, PPM
MLSS	5639	5000 - 6900
BOD_5, Equalized Feed	1458	925 - 1995
BOD_5, Effluent	403	280 - 589
BOD_5, Reduction	74%	---
COD, Equalized Feed	3080	1750 - 5745
COD, Effluent	1276	625 - 1850
COD, Reduction	59%	---
Phenol Reduction	99+%	---
TS, Equalized Feed	3480	2398 - 4500
VTS, Equalized Feed	908	---
SS, Equalized Feed	102	45 - 210
VSS, Equalized Feed	83	---
DS, Equalized Feed	3740	2298 - 4440
TS, Effluent	3250	2990 - 3656
VTS, Effluent	684	---
SS, Effluent	97	45 - 240
VSS, Effluent	86	---
DS, Effluent	3220	2949 - 3591

Simultaneously the batchwise daily addition of nutrients (aqua ammonia and phosphoric acid) to the system was resumed using a feed ratio (weight basis) of 100:5:1/BOD_5:N:P. Rates were adjusted to provide a retention time of six days in the oxidation tank. Within three days the system performance improved significantly. BOD_5 reduction rose to and stayed at 90+%, COD reduction increased to the 70 - 80% range; phenol reduction remained at 99+%.

As this period continued, the MLSS decreased, even with 100% sludge recycle; loading was low as the F/M ratio averaged only 0.08. After twelve days' operation, the feed rate to oxidation tank was increased to provide only four days' retention time. MLSS increased and remained in the 5000± ppm range, loading remained about the same as previously, BOD_5 removal increased to about 95%, COD removal increased to about 80%, and phenol removal remained at 99+%.

Performance data and operating parameters for the period are summarized in Table IV-6.

Sixth Developmental Period, February 25, 1971 - March 31, 1971

In order to move the system into the accepted activated sludge mode of operation, the feed to the oxidation tank was increased on February 25 to provide forty-eight hours' retention time. This step increased the loading to give an average F/M ratio for the period of 0.23. Concurrently, a sludge removal or wasting program was initiated in a batchwise mode to maintain a MLSS level between 4500 and 5000 ppm. This step gave theprocess a more favorable sludge age and moved the process from the endogenous phase into the conventional range. Examination of the pertinent performance and operating data summarized in Table IV-7 indicates that the pilot biological oxidation treatment plant operated continuously for a period of over thirty-one days while meeting the three stated project objectives. BOD_5 removals of 98% or better were maintained, COD removals of 80% or better were maintained, and phenol removals approached 99.9%. Since the stated project objectives had been achieved, operations were terminated, the pilot plant was run empty and cleaned.

Table IV-6. DEVELOPMENTAL PERIOD V SUMMARY

Average Flow, Parshall Flume		0.55 MGD
Equalization Time, T-1		24 Hrs.
Retention Time, T-7		144 - 96 Hrs.
Dilution Ratio		None
Sludge Recycle		100%
Organic Loading, F/M Ratio		0.08
pH, Equalized Feed		11.4
pH, Effluent	8.3	
DO Uptake, T-7		189 Mg/l/hr.
	Average, PPM	Range, PPM
MLSS	4130	2020 - 5820
BOD_5, Equalized Feed	1271	380 - 2400
BOD_5, Effluent	47	7 - 173
BOD_5, Reduction	96%	---
COD, Equalized Feed	3427	1723 - 6020
COD, Effluent	796	341 - 1169
COD, Reduction	77%	---
Phenol Reduction	99+%	---
TS, Equalized Feed	4443	1108 - 8700
VTS, Equalized Feed	1658	---
SS, Equalized Feed	158	15 - 765
VSS, Equalized Feed	95	---
DS, Equalized Feed	4351	1063 - 9157
TS, Effluent	4969	3396 - 6778
VTS, Effluent	743	---
SS, Effluent	127	5 - 325
VSS, Effluent	95	---
DS, Effluent	4165	3236 - 6448

Table IV-7. DEVELOPMENTAL PERIOD VI SUMMARY

Average Flow, Parshall Flume	0.52 MGD
Equalization Time, T-1	24 Hrs.
Retention Time, T-7	48 Hrs.
Dilution Ratio	None
Sludge Recycle	To maintain MLSS 4500 - 5000 PPM
Organic Loading, F/M Ratio	0.23
pH, Equalized Feed	10.3
pH, Effluent	7.8
DO Uptake, T-7	24.1 Mg/l/hr.

	Average, PPM	Range, PPM
MLSS	4896	4020 - 9500
BOD_5, Equalized Feed	1974	471 - 5040
BOD_5, Effluent	43	8 - 159
BOD_5, Reduction	98%	---
COD, Equalized Feed	4022	1538 - 8758
COD, Effluent	676	337 - 1020
COD, Reduction	82%	---
Phenol Reduction	99+%	---
TS, Equalized Feed	4979	2196 - 10234
VTS, Equalized Feed	1238	---
SS, Equalized Feed	158	10 - 800
VSS, Equalized Feed	101	---
DS, Equalized Feed	4945	2096 - 10194
TS, Effluent	3475	2228 - 4812
VTS, Effluent	615	---
SS, Effluent	204	60 - 430
VSS, Effluent	153	---
DS, Effluent	3125	1924 - 4593

PRIMARY TREATMENT COAGULATION EXPERIMENTS

Discussion

A primary treating system comprises units designed to reduce the physical and/or biological load imposed by the feed waste on the biological oxidation or secondary unit. As a minimum, a primary treating system should produce a feed for the biological oxidation unit that is free of floating and settleable solids. These objectives are relatively easy to achieve. Desirably, a primary treating system should also remove colloidal or difficultly settleable solids. Since this latter type solids can be coagulated and easily settled under proper conditions, a coagulation investigation was undertaken concurrently with the pilot plant start-up period.

Attempts to coagulate the equalized waste from equalization tank T-1 using several coagulants and two polyelectrolytes were carried out to determine:

1. Extent of BOD and COD reductions.

2. Whether total solids can be reduced.

3. Extent of removal of turbidity and color bodies.

Also, removal of colloidal particles, if present, by coagulation will increase the rate of metabolism of organics by microorganism and thus help decrease the retention time in the activated sludge unit. Organic matter that exists in true solution is readily available, but that part which occurs in colloidal and coarse suspension must await hydrolytic action before it can diffuse into the bacterial cells where auto-oxidation can occur.

Theory

Chemical coagulation is the process of destabilizing and agglomerating discreet charged particles that constantly remain dispersed in a media due to the repelling force of their like charge. These discreet particles or colloidal dispersions range in size from about 1 to 1000 millimicrons (mμ) and are not visible even with the aid of the ordinary high-powered microscopes. Since all colloidal particles are electrically charged, the charge varies in magnitude with the nature of the colloidal matter and may be positive or negative. Colloidal dispersion of solids in water is of two types: water-hating (hydrophobic) and water-loving (hydrophilic). Hydrophilic substances are products of plant and animal life such as starches and gum arabic. Colloidal particles in Reichhold's case are hydrophobic. The stability of hydrophobic colloids depends upon the magnitude of the charge, called the zeta potential, "Z." The zeta potential is defined:

$$Z = 4\Pi \frac{dq}{D}$$

Where "q" is the charge of the particles, "d" is the thickness of the charge, and "D" is the dielectric constant of the liquid.

Chemical coagulation is, therefore, a process to reduce the zeta potential below the intermolecular attractive force between particles, called the Van der Waals force, thus allowing particles to coalesce into a settleable coagulated floc.

Results

The data presented in the following pages indicate that use of any of the usual coagulants achieves, at best, only marginal results in terms of BOD_5 or COD reduction when used with the particular effluent stream employed for this work. See Table IV-8.

Lime, alum, ferric chloride, and Dow C-31 and Dow A-21 polyelectrolytes were used to effect coagulation of the equalized raw waste. Sulfuric acid invariably precipitated a usually red-brown colored material from the equalized raw waste whenever the pH dropped to pH 5 ± 0.5 and below. The settled precipitate left behind a fairly colorless supernatant. This acid-produced supernatant could not be further coagulated and only after addition of excessive coagulation dosages, e.g., 2000 ppm alum, did very light floc appear. Due to this phenomenon, the evaluation of the effectiveness of the above mentioned coagulants could only be determined at a pH range above pH 5 ± 0.5 before precipitation could occur.

Alum and Dow C-31 coagulated best at a pH range of pH 8 - to - pH 9. Lime, when applied alone, did not precipitate, but lime followed by Dow C-31 coagulated. This combination produced similar results when applied at pH

Table IV-8. COAGULATION RESULTS SUMMARY

Coagulant	Dosage (PPM)	Optimum pH	BOD Reduction	COD Reduction	Solids Reduction[1]	Settling Rate*
Alum	650	8.0 - 9.0	$\bar{x}$ = 13.3%	$\bar{x}$ = 10.7%	No change	341 gpd/Sq. Ft.
Dow C-31	75	8.0 - 9.0	$\bar{x}$ = 16.8%	$\bar{x}$ = 13.4%	No change	341 gpd/Sq. Ft.
Lime Plus Dow C-31	3000 65	8 - 12	$\bar{x}$ = 31.7%	$\bar{x}$ = 18.6%	$\bar{x}$ = 5.9%	405 gpd/Sq. Ft.
Sulfuric Acid	Varies	Below 5.0	10.9%	$\bar{x}$ = 8.5%	5.2%[2]	389 gpd/Sq. Ft.

[1] In supernatant.

[2] Increase.

*Expressed as permissible settler overflow rate.

ranges between pH 8 and pH 12. $FeCl_3 \cdot 6H_2O$ did not effect any coagulation at any pH range. Dow A-21 also did not effect any coagulation.

The combined lime + Dow C-31 produced an average BOD and COD reduction of 31.7% and 18.6%, respectively. An effective dosage to ensure coagulation of day to day variations of equalized raw characteristics would be 3000 ppm lime followed by 65 ppm C-31. All coagulant dosages mentioned below are concentrations that can effect coagulations of everyday variations of equalized raw feed (T-1) characteristics. Since the daily pH of the equalized raw is between pH 8 and pH 11, no change of pH was carried out before the addition of the lime and C-31. Total solids in the treated supernatant was reduced by an average value of 5.9%.

Alum, 650 ppm, produced average BOD and COD reductions of 13.3% and 10.7% respectively. There was no change in total solids of the treated supernatant.

Dow C-31, 75 ppm produced average BOD and COD reductions of 16.8% and 13.14%, respectively. No change in total solids.

The supernatant of the H_2SO_4-treated equalized raw exhibited average BOD and COD reductions of 10.9% and 8.4%, respectively. Total solids in this acid-treated supernatant increased by an average percentage of 5.2%, mainly due to an increase in sulfates.

Experimental

Lime--Lime by itself did not result in any coagulation as shown by Table IV-9.

Lime + Dow C-31--Lime followed by polyelectrolytic Dow C-31 caused coagulation of the equalized raw waste. Table IV-10 shows optimum pH range, which is anywhere between pH 8 and pH 12.

Figure IV-3 shows the settling test curve for lime + Dow C-31. From this curve it may be calculated that the permissible clarifier overflow rate is 405 gpd/sq. ft.

$FeCl_3 \cdot 6H_2O$--No coagulation was formed at any pH ranges using up to 1000 ppm dosages.

Table IV-9. LIME COAGULATION EFFECTIVE pH RANGE

pH	Dosage	Result
4	6000 PPM	No coagulation
5	"	"
6	"	"
7	"	"
8	"	"
9	"	"
10	"	"
11	"	"
12	"	"

Table IV-10. LIME = DOW C-31 COAGULATION EFFECTIVE pH RANGE

pH	Dosage (PPM) Lime	Dosage (PPM) C-31	Result	% COD Reduction
5	4000	100	No coagulation	-
6	4000	100	No coagulation	-
7	4000	100	Floc formed	8.4
8	3000	60	Floc formed	12.8
9	3000	75	Floc formed	18.0
9	3000	50	No coagulation	-
9	2700	60	No coagulation	-
10	3000	60	No coagulation	12.9
11	3000	60	No coagulation	12.0
12	3000	60	No coagulation	12.2

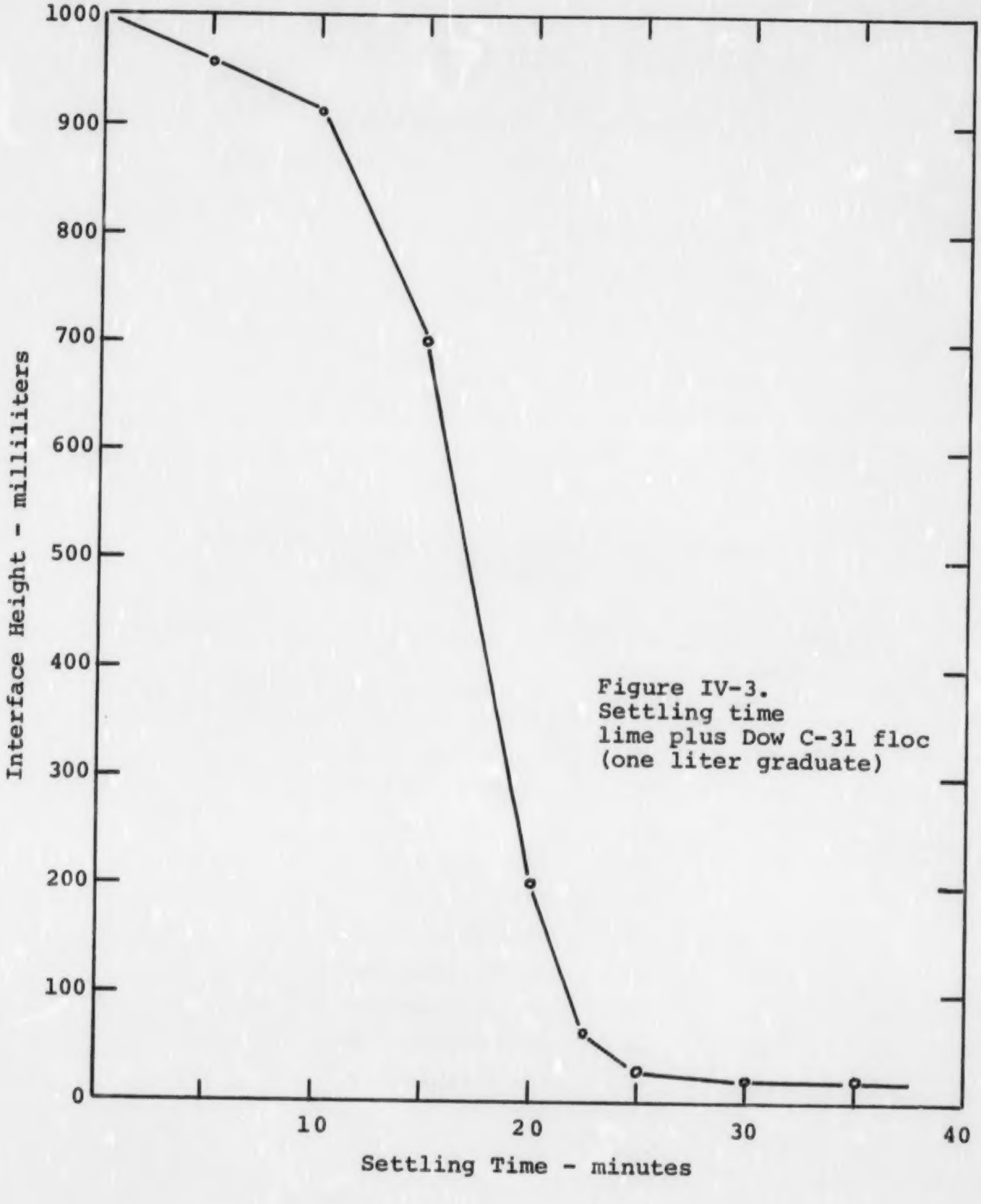


Figure IV-3.
Settling time
lime plus Dow C-31 floc
(one liter graduate)

Alum--Table IV-11 gives optimum pH range for alum and % COD reduction.

From Table IV-11 it can be seen that pH 8.5 ± 0.5 is the optimum pH range. Figure IV-4 shows the settling curve for alum. It may be calculated that the permissible clarifier overflow rate is 341 gpd/sq. ft.

Dow C-31 and Dow A-21--Table IV-12 shows the optimum pH range for coagulation - pH 8.5 ± 0.5 for C-31 - and indicates ineffectiveness of Dow A-21 as a coagulant.

Figure IV-5 shows the settling curve for Dow C-31. The permissible clarifier overflow rate for the Dow C-31 floc is calculated to be 341 gpd/sq. ft.

Sulfuric Acid--As mentioned, H_2SO_4 invariable precipitated the equalized raw at pH 5 ± 0.5 and below.

Figure IV-6 shows the neutralization curve of equalized raw using concentrated H_2SO_4.

Figure IV-7 shows settling curve for acid-formed precipitate. The corresponding calculated clarifier overflow rate is 389 gpd/sq. ft.

Table IV-13 gives results for alum and H_2SO_4-treated equalized raw, and lists among other things changes in phenol, nitrogen and phosphorus contents in supernatant.

TERTIARY TREATMENT EXPERIMENTS

Introduction

Concurrently with the less satisfactory periods of pilot plant operation, a number of experiments were made to determine the possible effectiveness of some type of tertiary waste treatment for COD reduction. The results of these experiments are summarized herein.

Treatment of the pilot plant final effluent in the continuous mode using activated carbon appears to be surprisingly effective for COD removal. Additional laboratory investigations followed by operation of a pilot or prototype plant unit might, and ultimately did, indicate carbon adsorption to be a viable primary treatment method.

Chlorination of the final effluent exhibited lower COD removal than did carbon adsorption. A more important

Table IV-11. ALUM COAGULATION EFFECTIVE pH RANGE

pH	Dosage (PPM)	Result	% COD Reduction
5	2000	No coagulation	-
6	2000	No coagulation	-
7	800	Floc formed	10.8
8	650	Floc formed	13.3
9	650	Floc formed	13.4
10	800	Floc formed	13.0
11	1200	Floc formed	12.8

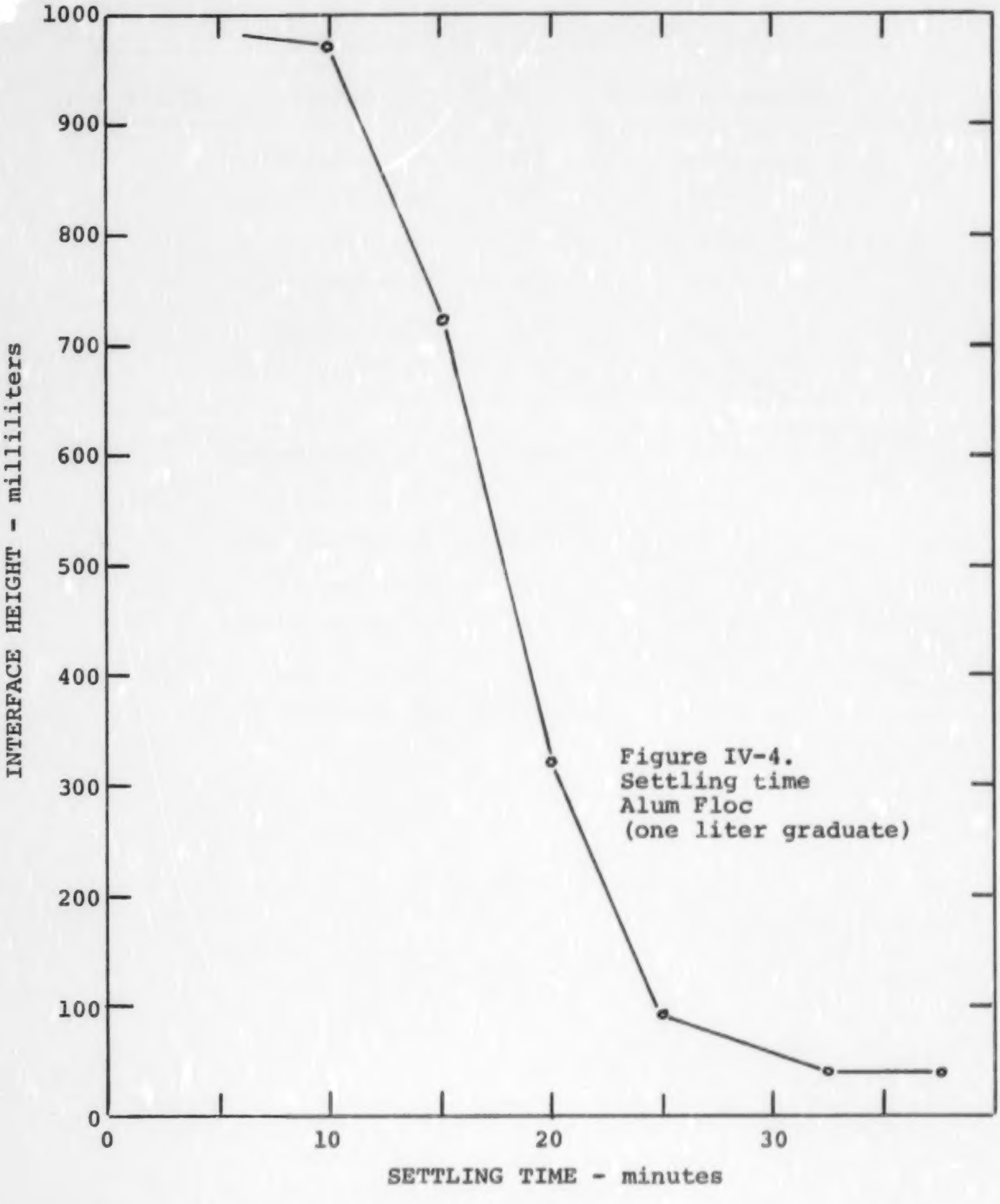


Figure IV-4.
Settling time
Alum Floc
(one liter graduate)

Table IV-12. DOW C-31 AND A-21 COAGULATION EFFECTIVE pH RANGE

pH	Polyelectrolyte	Dosage (PPM)	Result	COD % Red.
4	C-31	200	No coagulation	-
	A-21	200	No coagulation	-
5	C-31	200	No coagulation	-
	A-21	200	No coagulation	-
6	C-31	100	Floc formed	13.7
	A-21	200	No coagulation	-
7	C-31	100	Floc formed	13.5
	A-21	200	No coagulation	-
8	C-31	75	Floc formed	12.3
	A-21	200	No coagulation	-
9	C-31	75	Floc formed	12.3
	A-21	200	No coagulation	-
10	C-31	120	Floc formed	14.5
	A-21	200	No coagulation	-

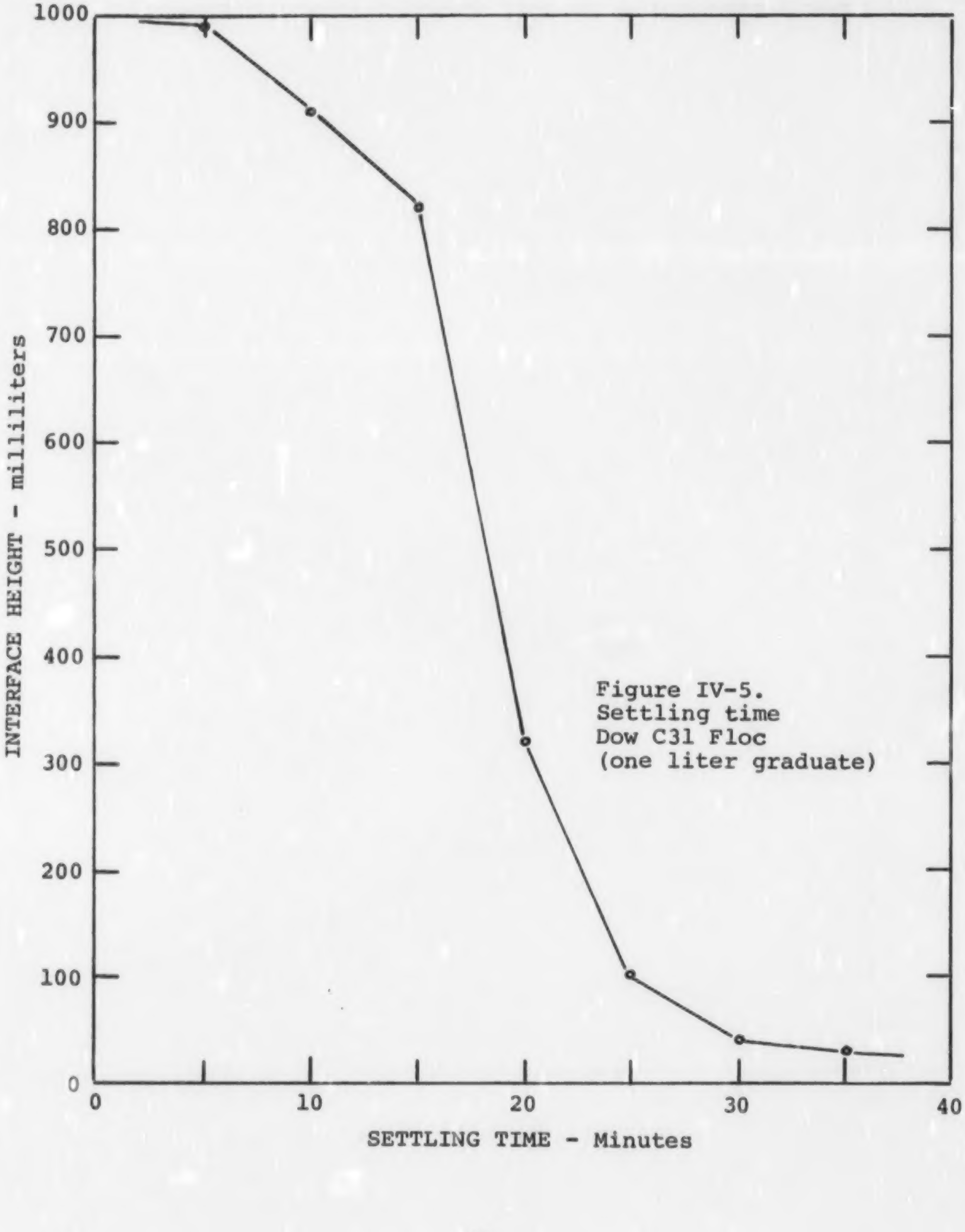


Figure IV-5.
Settling time
Dow C31 Floc
(one liter graduate)

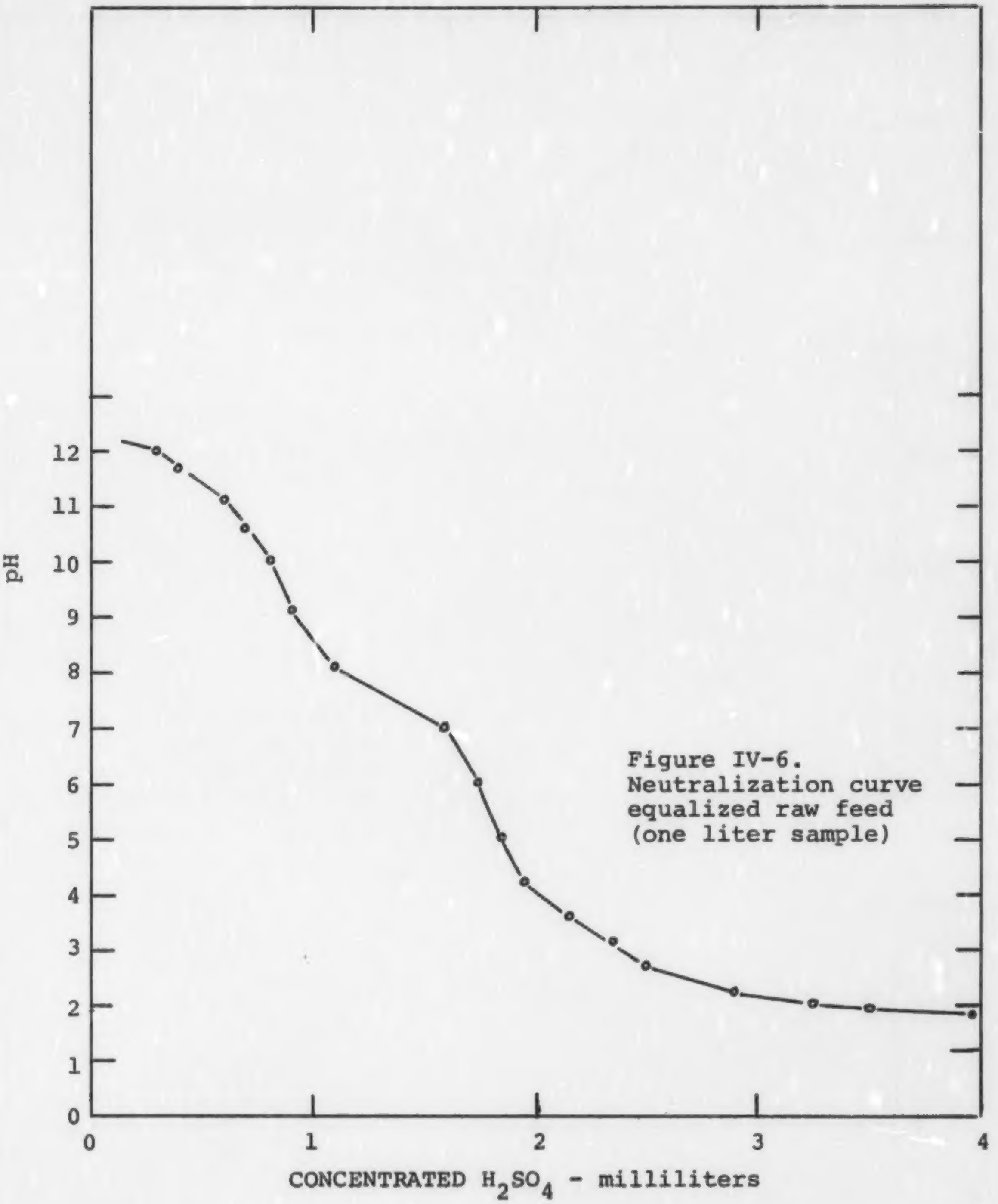


Figure IV-6.
Neutralization curve
equalized raw feed
(one liter sample)

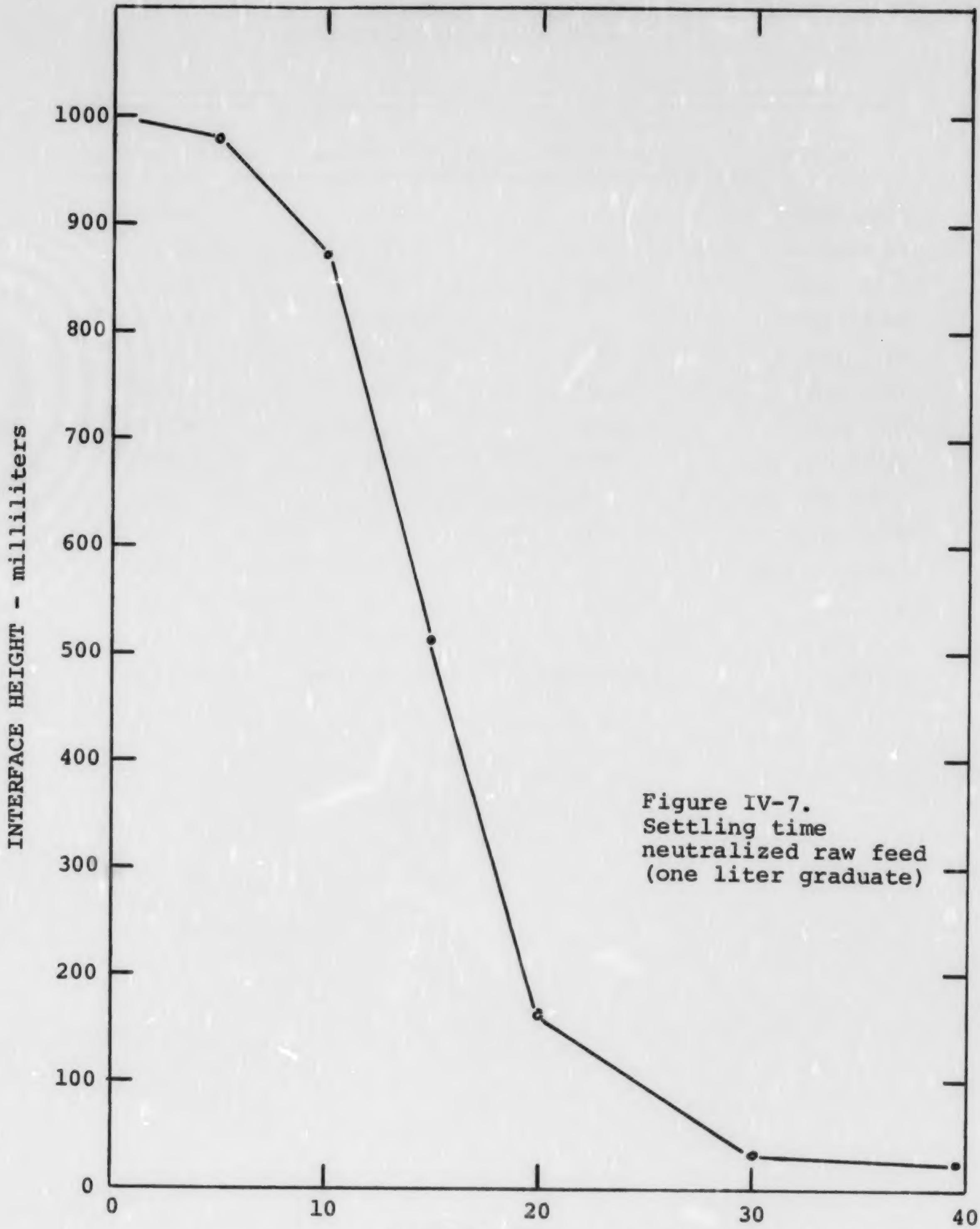


Figure IV-7.
Settling time
neutralized raw feed
(one liter graduate)

Table IV-13. SUMMARY - COAGULATION RESULTS ALUM AND ACID TREATMENTS

Sample	Equalized Raw Feed	Alum Treated	Acid Treated
COD, ppm	3610	3470	3355
Reduction		3.9	7.1
BOD, ppm	2400	2225	2100
Reduction		7.3	12.6
SS, ppm	136	28	20
TS, ppm	4580	4346	4338
DS, ppm	4444	4314	4318
Sulfate, ppm	750	825	900
Sulfite, ppm	40	10	10
Fe, ppm	40	0	2
Phenol, ppm	325	225	137
N, ppm	321	313	42
P, ppm	49	43	48
Color	Red-brown	Faint yellow	Colorless

disadvantage versus carbon would lie in the formation of chlorophenols from even the very low residual phenol content of the pilot plant final effluent.

Sand filtration of the final effluent reduced its COD content by only 18%

Coagulation exhibited poor COD removal.

Acidification of the final effluent effected substantial COD removal. The amount of acid required, the type of acid-resistant equipment needed, and the alkali required for final waste neutralization would not make this a viable tertiary treating step.

Carbon Treating, Theory

Adsorption of COD-contributing molecules occurs due to their selective adsorption by surface carbon molecules suffering an uneven balance of force in contrast to inner surface molecules that are subjected to equal forces in all directions. This adsorption is known as "physical" or "Van der Waals adsorption." Adsorption can also be due to a chemical interaction between the solid and the solute molecules. Chemical adsorption subsides after the formation of a monomolecular layer and physical adsorption subsides after several superimposed layers are formed. Chemical adsorption has stronger sorption powers and is seldom reversible as physical sorption is. It is hard, however, to assign the adsorption definitely to one of these types. Freundlich showed that adsorption of solutes from solutions could be expressed as:

$$x/m = kC^{1/n}$$

or

$$\log x/m = \log k + 1/n \log C$$

where C = concentration of solute after adsorption,

x/m = amount of material adsorbed per unit wt. of adsorbent,

k and n are constants.

If removal of contaminants is due to adsorption, plotting of log x/m vs. log C will produce a straight line.

Carbon Treating, Batch Adsorption

Batch adsorption of the Bio-treated effluent was carried out using 325-mesh Darco.* The effluent was stirred with the powdered carbon for thirty minutes using various quantities of carbon. After settling of the spent carbon, the supernatant was filtered and its residual COD content was determined.

Figures IV-8 and IV-9 are Fruendlich Isotherm plots showing straight lines attained when log x/m was plotted vs. log C.

Figures IV-10 and IV-11 show pounds carbon/1,000 gallons bio-treated effluent used versus COD remaining. Percent of COD removal is also plotted on the same graphs.

Carbon Treating, Continuous Adsorption

Although batch adsorption provides useful information on the effectiveness and application of adsorption to the removal of the COD, continuous carbon filters provide the most practical application of this process in waste treatment. The reasons for this are that a subsequent carbon separation step is not required; that higher removals in equilibrium with the influent concentration rather than the effluent concentration can be approached; and a greater flexibility of operation can be attained.

Since batch adsorption proved effective in removing COD-contributing molecules, a 2" ID glass column was set up containing a 2' Darco 12 x 20 mesh carbon bed, having 10" of freeboard and supported on 2" of glass wool. Before operation, the bed was backwashed to release entrapped air and prevent channeling. Darco 12 x 20 mesh was selected as pressure drop for that particular size is 2.0 to 3.4 times less than that for 12 x 40 mesh carbon.

Bio-treated effluent was continuously metered into the top of the carbon column at a feed rate of 1 gpm/ft^2. Before its introduction into the glass column, the effluent was passed through a funnel containing glass wool to filter suspended solids. During the period of operation, the biological oxidation tank was experiencing unusually high shock loads and this resulted in dispersed growth in the effluent and consequently a high suspended solid content.

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*Atlas Chemical Industries, (now I.C.I. America, Inc.) Wilmington, Del.

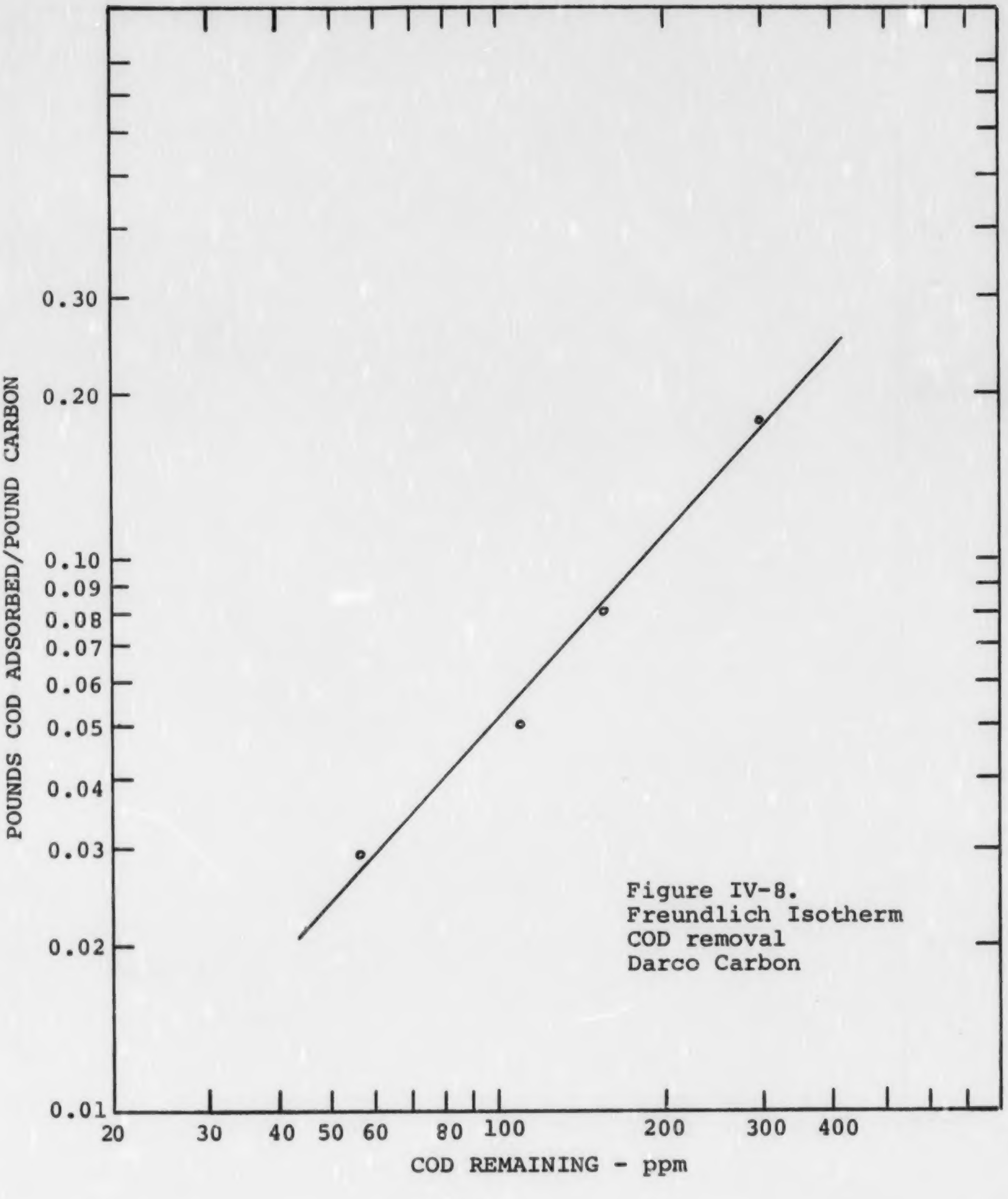

Figure IV-8.
Freundlich Isotherm
COD removal
Darco Carbon

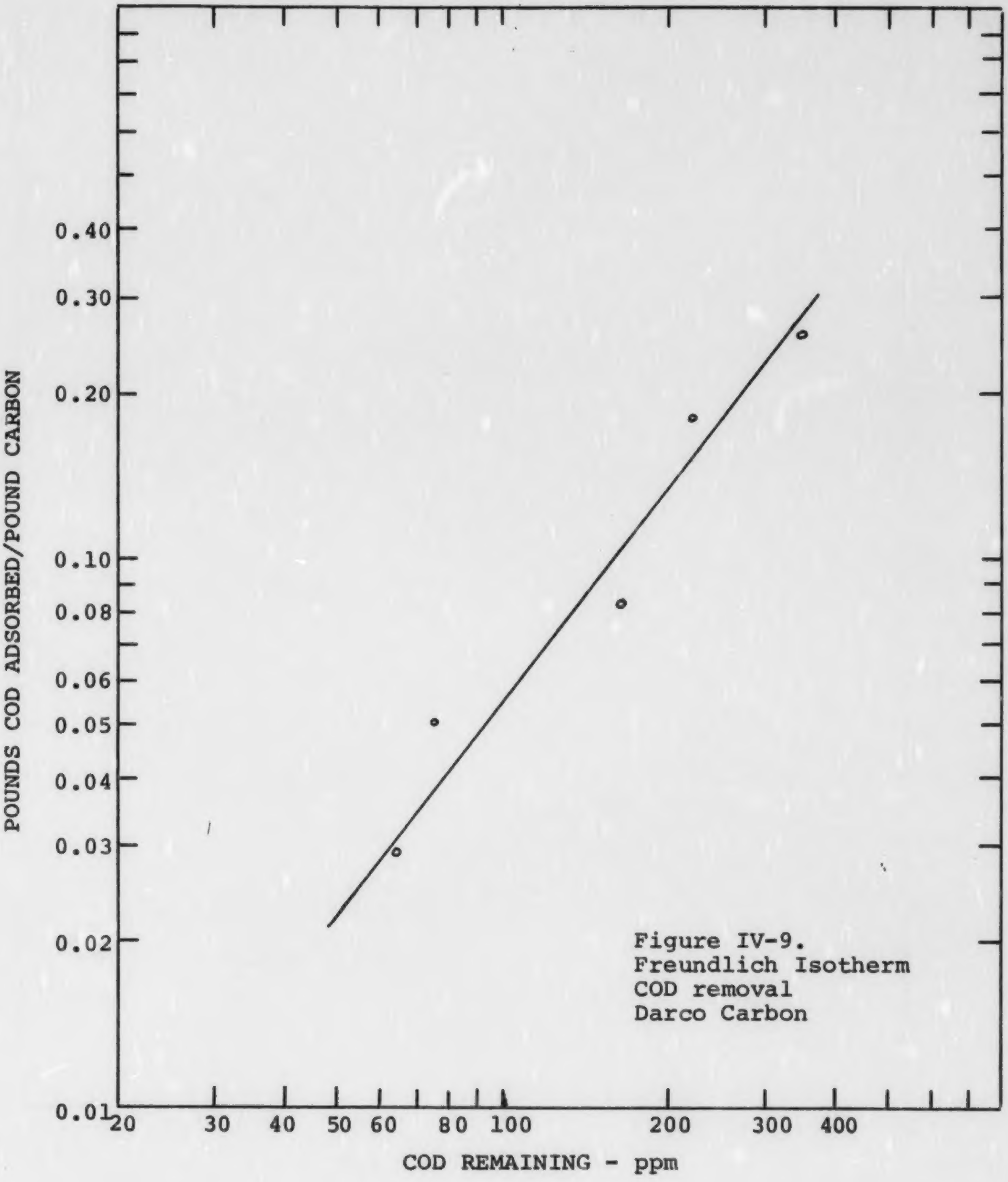

Figure IV-9.
Freundlich Isotherm
COD removal
Darco Carbon

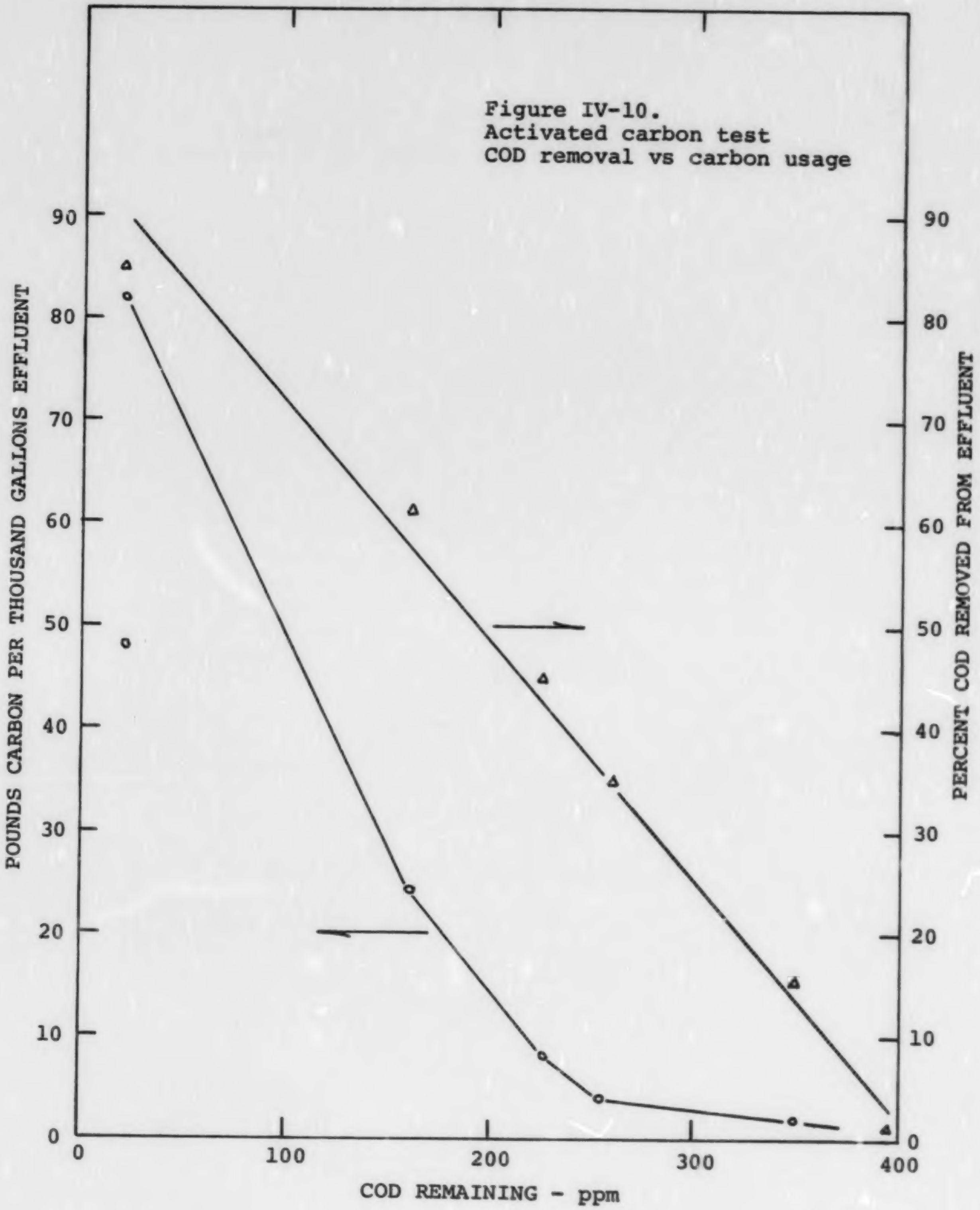

Figure IV-10.
Activated carbon test
COD removal vs carbon usage

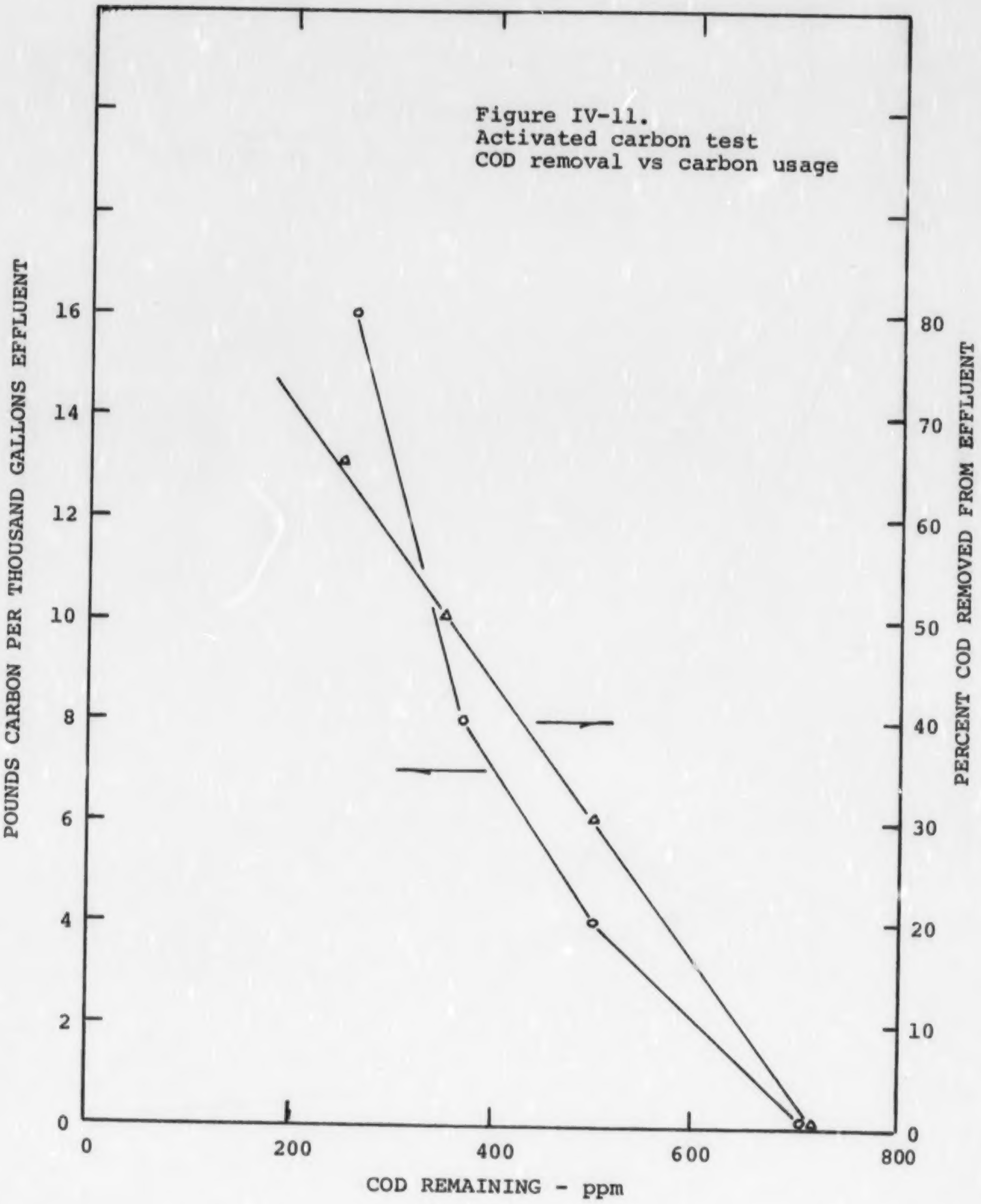
Figure IV-11.
Activated carbon test
COD removal vs carbon usage

The glass wool-filtered effluent during that period averaged a suspended solid content of 130 mg/l. The bed was backwashed three times during the eleven-day experiment period to eliminate pressure drops across the bed and maintain the flow rate of 1 gpm/ft^2.

Results of the continuous carbon test are shown in Figure IV-12.

Feasibility of thermal regeneration, steam regeneration, and solvent regeneration followed by steam regeneration of the spent granular carbon were not investigated.

Chlorination

Chlorination is a potent oxidation process in which certain oxygen-demanding molecules are oxidized, thus eliminating their BOD and COD. Chlorination often dissipates itself in side reactions so rapidly that little oxidation or disinfection is accomplished until amounts of chlorine in excess of the breakpoint have been added. Unsaturated organics are saturated and phenols will produce mono-, di-, and trichlorophenols which can impart taste and odor to waters.

Chlorine in the form of a 5.25% aqueous solution of sodium hypochlorite (NaOCl) was employed for the experiments tabulated in Table IV-14. The indicated amounts of hypochlorite solution, ranging from 0.5 to 5.0 weight percent, were added to liter portions of the effluent from the pilot treating plant. The treated samples were agitated at ambient temperature for fifteen (15) minutes in the dark; thereafter portions of the treated samples were analyzed for COD.

Based on a flow of 0.5 MGD of waste from the RCI plant, between 6000 and 7000 pounds of sodium hypochlorite would be required per day to effect a 30% reduction in the plant effluent COD.

Sand Filtration

A 2-foot deep sand bed contained in a 2-inch diameter glass column was used for this experiment. Effluent from the pilot treating plant was fed through this sand bed continuously for a ten-day period at a rate of 0.2 gpm/ft^2. Total effluent from the sand filter was collected and analyzed on a twenty-four-hour basis. As in the continuous carbon adsorption test, the sand bed was backwashed

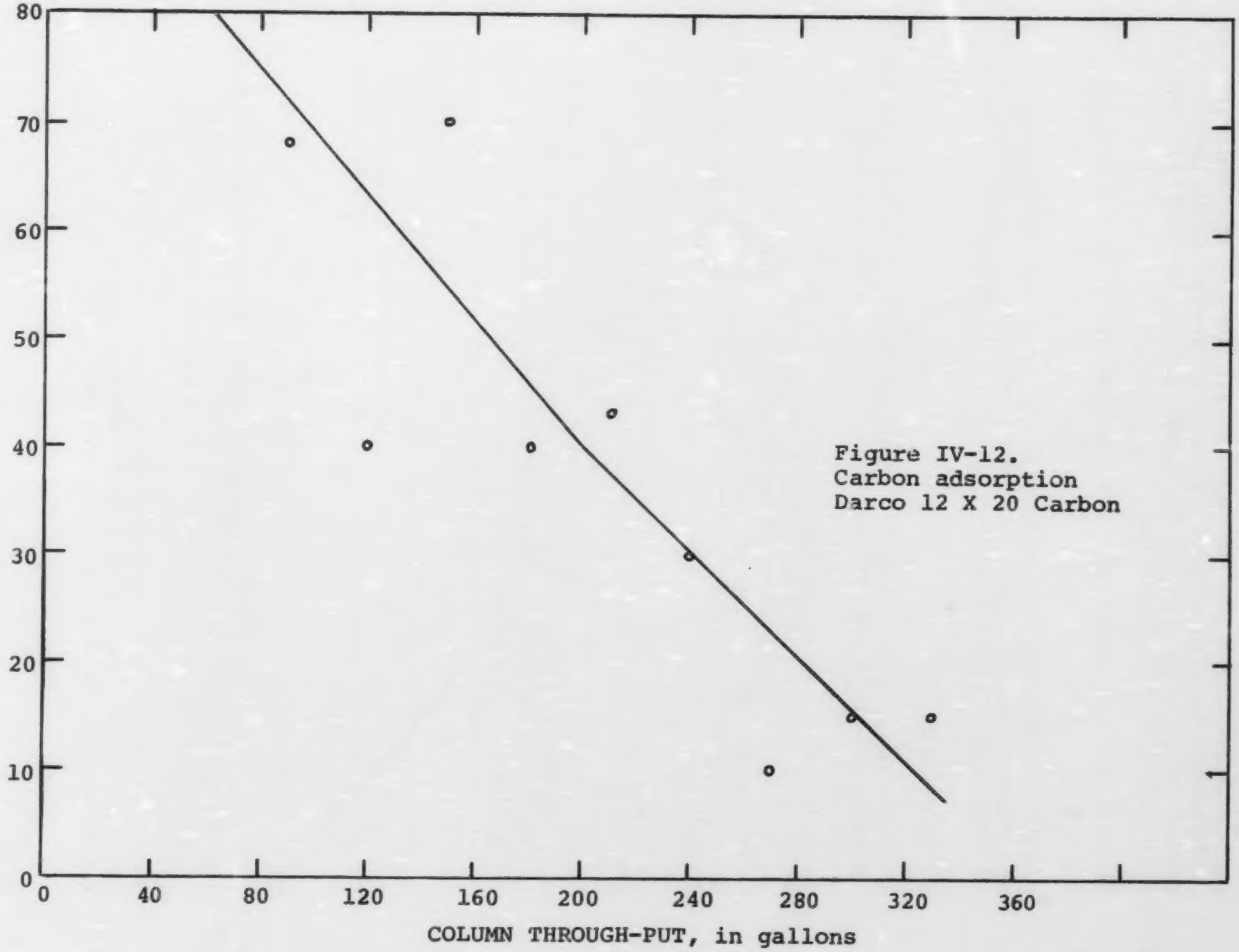

Figure IV-12.
Carbon adsorption
Darco 12 X 20 Carbon

Table IV-14. CHLORINATION DATA, MARCH '71
(all figures in ppm)

Date	18	19	21	24	26	27	28	29	30
Effluent, COD	777	724	754	989	637	884	755	681	584
Treated Effluent									
0.5% NaOCl	717	-	-	-	-	-	-	-	-
COD Reduction, %	7	-	-	-	-	-	-	-	-
1.0% NaOCl	706	-	-	-	-	-	-	-	-
COD Reduction, %	9	-	-	-	-	-	-	-	-
2% NaOCl	628	574	548	728	500	747	393	529	441
COD Reduction, %	19	20	27	23	21	15	35	22	24
3% NaOCl	557	512	485	676	444	653	356	478	387
COD Reduction, %	28	29	36	32	30	26	39	30	34
4% NaOCl	-	465	447	619	-	-	-	-	-
COD Reduction, %	-	36	41	38	-	-	-	-	-
5% NaOCl	-	441	-	-	-	-	-	-	-
COD Reduction, %	-	39	-	-	-	-	-	-	-

three times during the ten-day operating period. Data are summarized in Table IV-15. Average COD reduction amounted to 18% for this period.

Coagulation

Results obtained were so poor using conventional laboratory techniques that the experimental work will not be described.

Alum, Dow C-31 polyelectrolyte, and alum + Dow C-31 proved to have little effect in reducing COD of the effluent. Dow A-21 polyelectrolyte exhibited no coagulation effect whatsoever. Alum (200 ppm) effected 3% COD reduction, Dow C-31 (80 ppm) effected 16% COD reduction, alum (200 ppm) + Dow C-31 (25 ppm) effected 5% COD reduction.

Lime (1800 ppm) effected a COD reduction of 18%.

Acidification

Addition of sulfuric acid to the effluent from the pilot treating plant resulted in the formation of a precipitate or floc when the pH of the effluent had been reduced to the range of 2.0 - 3.0. After sedimentation of the flox, the COD of the clear supernatant was reduced by an average of 28% (Table IV-16). Settling tests, see Figure IV-13, indicate that a clarifier having an overflow rate of 2298 gallons per day per square foot would be required. In addition to floc formation, the sulfuric acid probably converts at least part of the sodium sulfite and sodium formate to sodium sulfate, thus reducing the COD contributed by these two oxidizable chemicals known to be present in the RCI waste. For acidifying 0.5 mgd of pilot plant effluent, Figure IV-14 shows that 500 gallons of 66° Bé sulfuric acid would be required. From Figure IV-15 one may calculate that 830 gallons of commercial 50% caustic liquor would be required daily to neutralize the acidified liquor.

Table IV-15. SAND FILTRATION EXPERIMENTAL DATA

Date	Pilot Plant Effluent COD	Filter Effluent COD	COD Removal
3-14-71	1020 PPM	889 PPM	13%
3-16-71	950	762	20
3-17-71	782	664	15
3-18-71	777	637	18
3-19-71	724	569	21
3-20-71	728	590	19
3-24-71	989	810	19

Table IV-16. EFFLUENT ACIDIFICATION DATA - pH - 2.0

	COD - PPM		
Date	Before Acidification	After Acidification	Reduction
2-10-71	809	508	37%
2-20-71	612	444	27%
2-23-71	341	256	25%
3-1-71	632	470	26%
3-5-71	689	414	40%
3-6-71	485	424	12%
3-8-71	552	381	30%

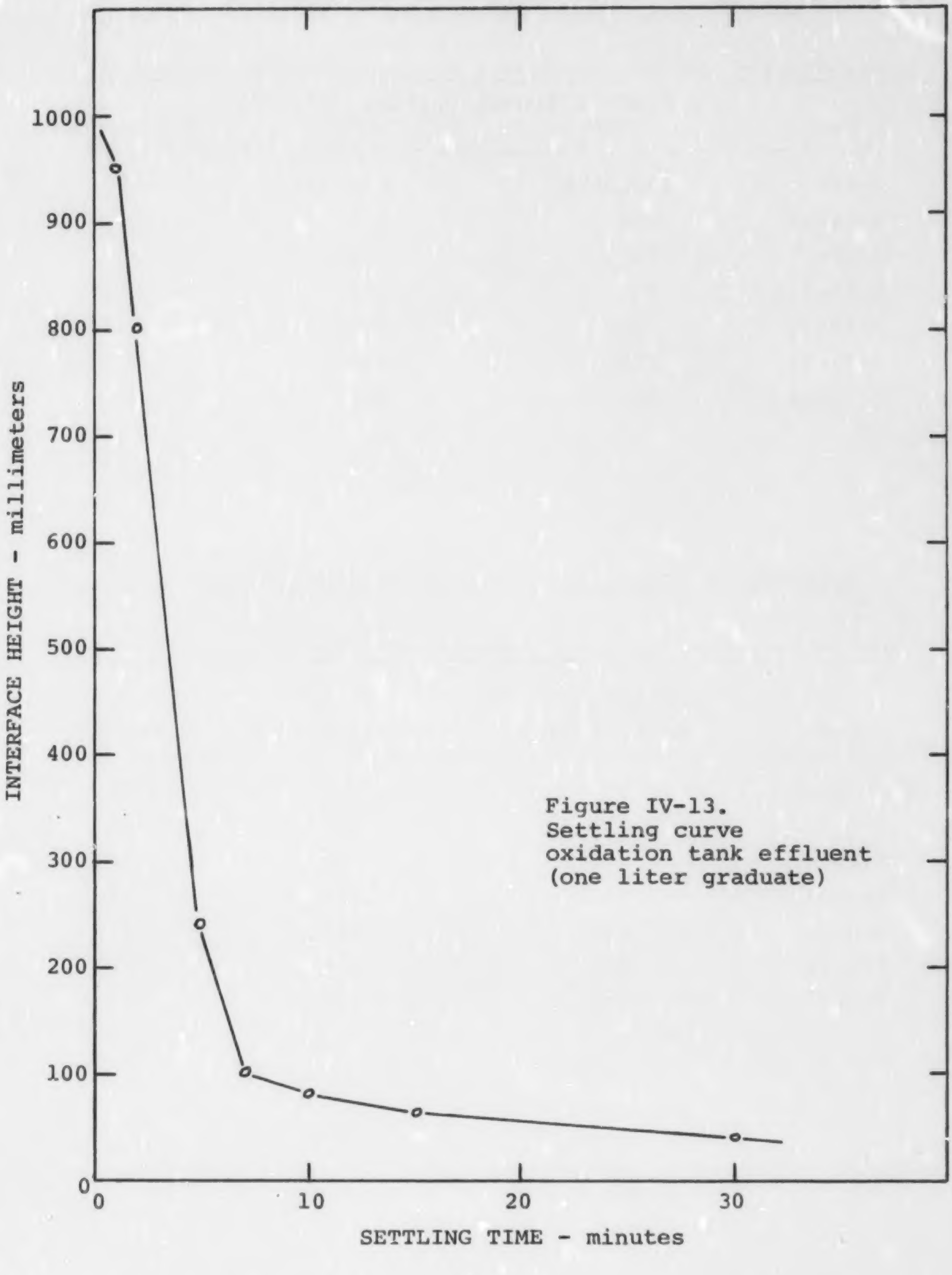

Figure IV-13.
Settling curve
oxidation tank effluent
(one liter graduate)

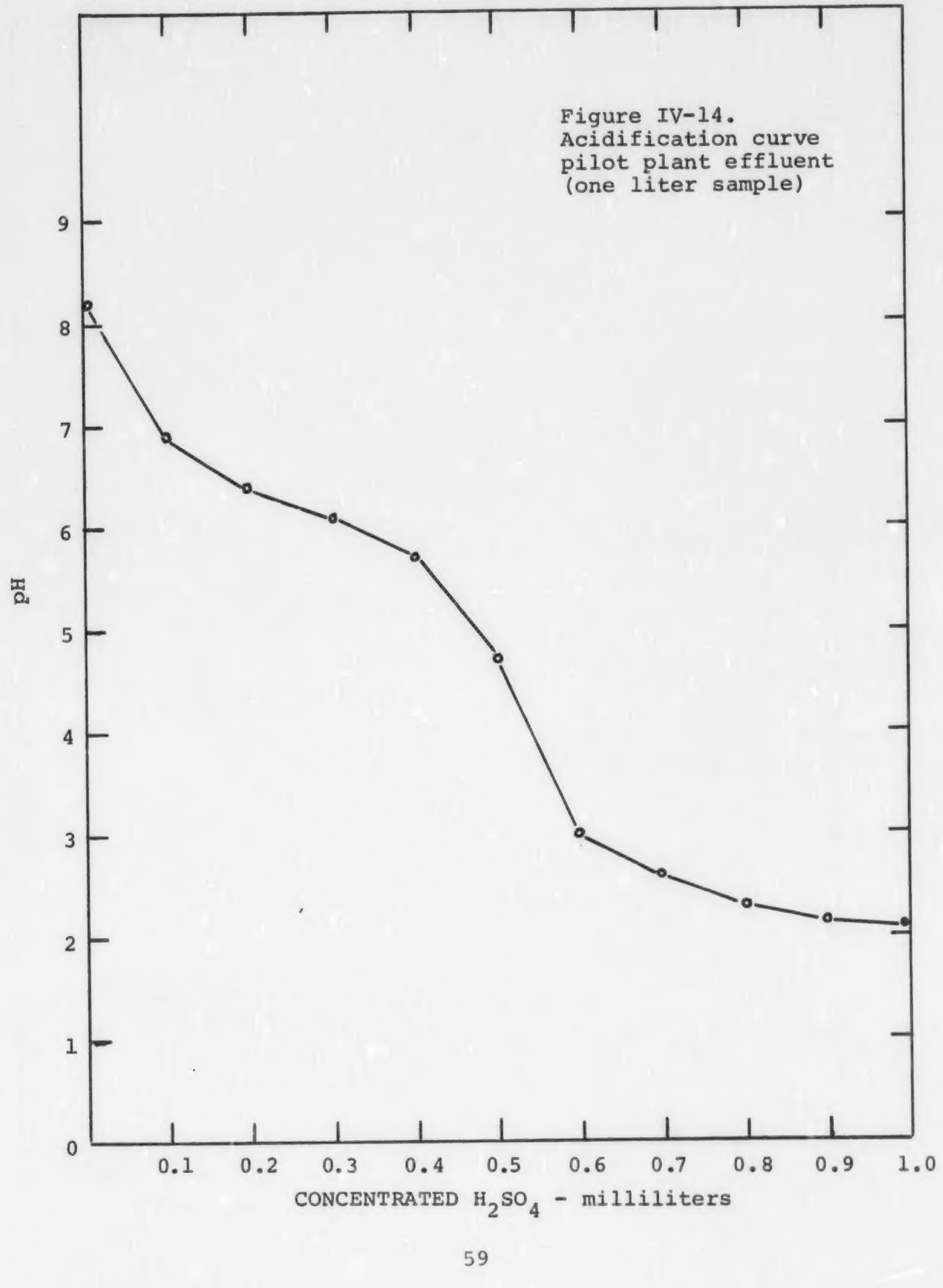
Figure IV-14. Acidification curve pilot plant effluent (one liter sample)

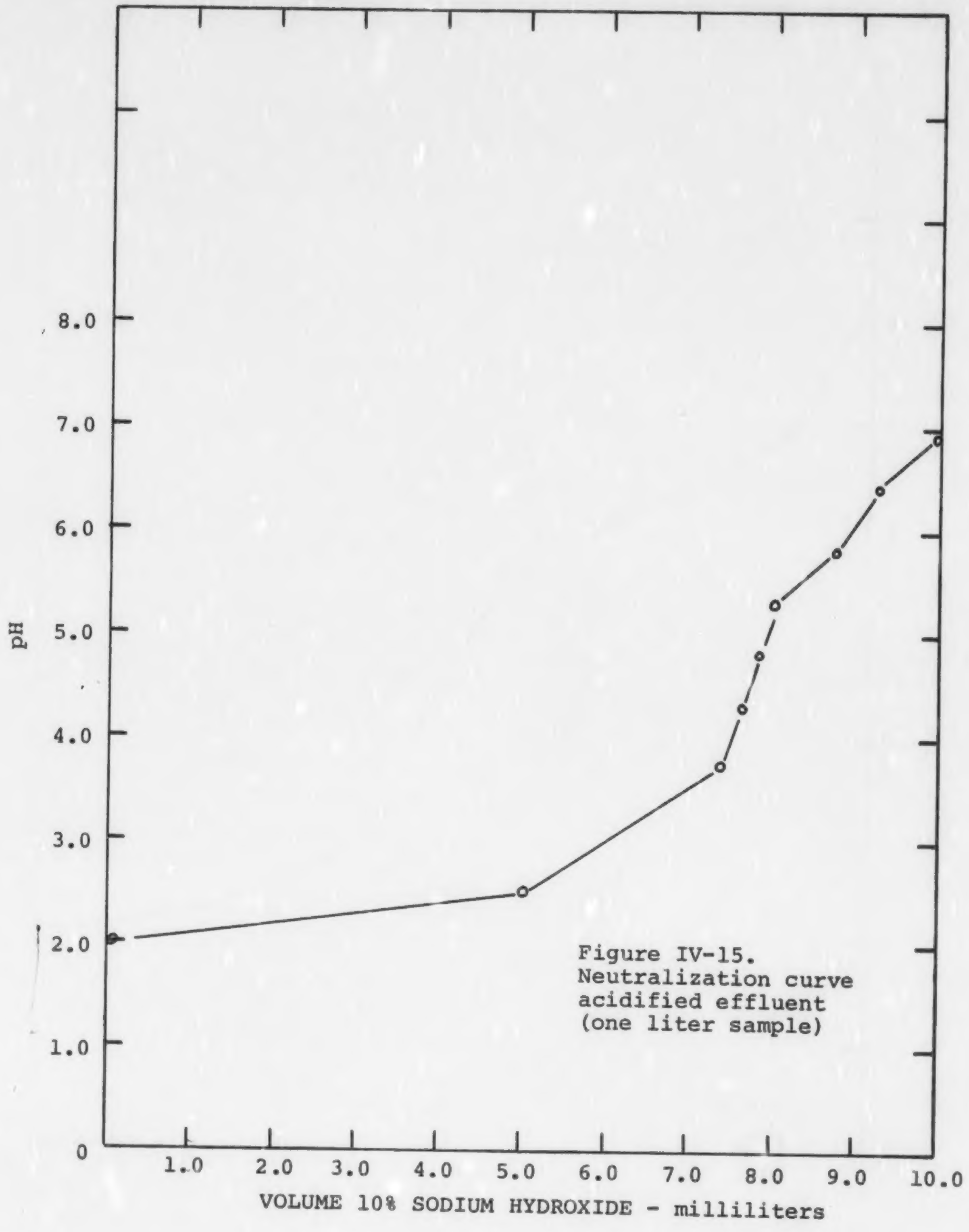

Figure IV-15.
Neutralization curve
acidified effluent
(one liter sample)

SECTION V

CARBON ADSORPTION PROCESS

DISCUSSION

As mentioned earlier, biological oxidation of the RCI waste, as a treating method, appeared to lack reliability. Activated carbon adsorption as a candidate process for waste purification was selected for a number of reasons:

1. The brief investigations of adsorption possibilities mentioned earlier and described in Section IV indicated that carbon adsorption offered promise as a waste treating process.

2. RCI already had limited experience with carbon adsorption as a decolorizing operation in its pentaerythritol production process.

3. As a process, activated carbon adsorption appeared to offer the best possibility for designing and building a waste treating unit that would meet the chronological deadline proposed by the AWIC for treatment of RCI's liquid waste.

LABORATORY INVESTIGATIONS

As mentioned above, activated carbon adsorption was briefly examined as a tertiary treatment or polishing operation for RCI liquid wastes that had already been subjected to primary and secondary biological treatment. Results obtained appeared promising. See Figures IV-10, IV-11. From the plotted data, it is evident that the two waste samples were markedly different in composition. One sample required a 5X increase in carbon to achieve the same reduction in COD content. Nevertheless, significant reductions in COD and, by implication, BOD_5 content were achieved.

In order to confirm the apparent suitability of activated carbon adsorption as a treating process, Freundlich isotherms were determined (duplicate determinations) on a sample of filtered but otherwise untreated Parshall flume waste. See Figures IV-8 and IV-9. The Freundlich isotherms, although preliminary, indicate that carbon adsorption would be a suitable treating method. Furthermore, the theoretical carbon efficiency (pounds of COD adsorbed per pound carbon) was of a magnitude that appeared to make adsorption economical if the spent carbon could be reactivated.

Based on these very preliminary results, additional laboratory work was undertaken.

Samples of the RCI waste were submitted to a commercial manufacturer of activated carbon* for a brief adsorption feasibility study. The pertinent characteristics of these samples are given in Table V-1. The sample identified as "Untreated" represents the material identified as "Parshall Flume Waste" in Figure III-1. The samples identified as "Treated" represent the Parshall flume waste that had undergone preliminary clarification, partial biological oxidation but not final clarification.

Following the analytical waste characterization reported in Table V-1, Freundlich adsorption isotherms were determined for each sample using Calgon Filtrasorb 300 activated carbon. The Freundlich isotherm (Figure V-1) confirmed the initial work that indicated activated carbon should be satisfactory. Pertinent data that result from the isotherm work - C(i), C(f) and removal - for the three samples are given in Table V-2.

Of especial significance are the "C(f)" and "removal" values for both SOC and COD in the untreated sample as given in Table V-2. As inferred in Appendix B-2, absolute numerical values for this type work in the laboratory may not correlate well with similar plant values. Even if the "C(f)" and "removal" values could not be exactly duplicated on a plant scale, they are nonetheless high enough to indicate that carbon adsorption might well be a satisfactory waste treating process.

Based on the very satisfactory laboratory results, further work on a larger, pilot scale was undertaken.

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*Calgon Corp., Pittsburg, PA

Table V-1. WASTE CHARACTERISTICS BEFORE CARBON TREATMENT

Sample	D-6035 Untreated	D-5673 Treated	D-5952 Treated
Sample Date	3-9-71	2-18-71	3-9-71
pH, As Taken	10.8	8.8	7.6
pH, Adjusted	7.0	7.0	7.6
TOC, As Taken	2100 mg/l	175 mg/l	238 mg/l
COD, As Taken	5950 mg/l	416 mg/l	770 mg/l
SS, As Taken	75 mg/l	175 mg/l	210 mg/l
BOD_5, As Taken	1170 mg/l	37 mg/l	33 mg/l
TOC, pH Adjusted	2100 mg/l	175 mg/l	-
COD, pH Adjusted	5950 mg/l	436 mg/l	-
SS, pH Adjusted	165 mg/l	200 mg/l	-

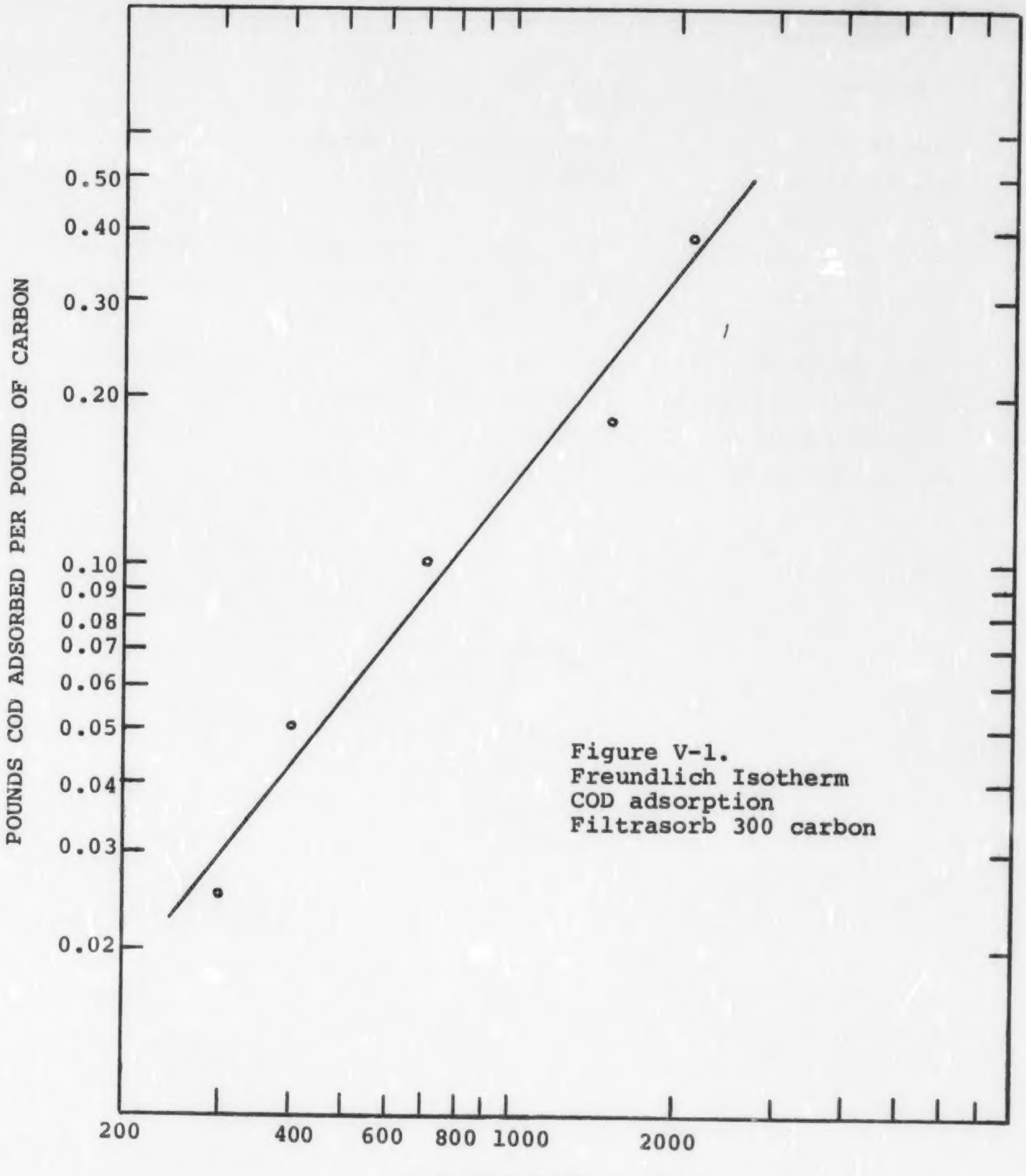


Figure V-1.
Freundlich Isotherm
COD adsorption
Filtrasorb 300 carbon

Table V-2. WASTE CHARACTERISTICS AFTER CARBON TREATMENT

Sample	D-6035 Untreated		D-5673 Treated		D-5952 Treated	
	SOC	COD	SOC	COD	SOC	COD
C(i) mg/l	2100	5950	175	312	170	520
C(f) mg/l *	173	475	3	6	6	16
Removal **	92%	92%	98%	98%	96%	97%

*Residual after treatment with highest carbon dosage.

**The isotherms indicate that additional removal could be expected using still higher carbon dosage.

PILOT PLANT INVESTIGATIONS

Sample Collection and Preparation

Because of the variable characteristics of the Parshall flume wastewater both with respect to flow and composition, collection and preparation of representative samples for use in these pilot studies was very carefully handled.

For use in these studies, 24-hour composite samples of waste were obtained on each of five consecutive operating days. A total of 250 gallons of waste was thus obtained. Automatic sampling devices were used to ensure collection of representative samples. These composite samples were the pH adjusted to approximately 2.0 in order to stabilize them biologically.

The five 55-gallon drum samples of waste were made available to the Water Management Division of the Calgon Corporation where these pilot plant studies were made. When the samples were received by the Calgon laboratory, shaken aliquots in proportion to the reported daily flow were taken from each drum, pH adjusted with 50% caustic solution back to the original pH and then composited. This final composite sample was used in making these studies. Analysis of the five drum samples and the final composite sample is shown in Table V-3. The final composite sample constitutes the material used in developing the information and data obtained in these studies.

Clarification Investigations

The suspended solids content of the final composite sample is much too high to handle in either a fixed or moving bed carbon unit. For this reason a clarification study was run on the final composite sample utilizing the following time and agitation sequences:

5 minutes at 100 rpm

5 minutes at 50 rpm

10 minutes at 20 rpm

30 minutes at 0 rpm

Tables V-4a and 4b show typical data obtained from these laboratory clarification studies. As can be noted, the

Table V-3. WASTE CHARACTERISTICS, PILOT PLANT FEED

Item	Date 5-11-71	 5-13-71	 5-14-71	 5-15-71	 5-16-71	Composite
Original pH	7.9	10.5	4.1	7.4	5.4	-
Adjusted pH	2.0	2.2	1.4	1.9	2.1	8.0
BOD_5, mg/l	2925	1320	1650	1710	3000	1425
COD, mg/l	8700	6000	10,000	5000	10,000	6745
Phenol, mg/l	435	588	1260	535	745	650
SS, mg/l	420	-	220	-	130	330
Flow, gpd	557,000	505,000	523,000	440,000	430,000	-
TOC, mg/l	-	-	-	-	-	2880

Table V-4a. CLARIFICATION RESULTS 1

Jar	Calgon Coagulant						Floc			Supernatant
	WT-2660	WT-2870	WT-2630	WT-2690	WT-2700	WT-3000	Formation	Size	Settle	Clarity
1	10 ppm						?	Poor	Poor	Poor
2		10 ppm					?	Poor	Poor	Poor
3			2.5 ppm				3 min	Fair	Fair	Good
4				2.0 ppm			1 min	Good	Good	Fairly good
5					2.0 ppm		3 min	Fair	Poor	Poor
6						2.0 ppm	?	Poor	Poor	Poor

Table V-4b. CLARIFICATION RESULTS 2

Jar	Calgon Coagulant		Floc Characteristics			Supernatant Clarity
	WT-2690	WT-2630	Formation	Size	Settle	
1	0.5 ppm		1 min	Fair	Fair	Fair
2	1.0 ppm		1 min	Good	Fair	Fair
3	2.0 ppm		1 min	Good	Good	Good
4		5.0 ppm	1 min	Fair	Fair	Very good

best results were achieved with the use of a nonionic polymer (Calgon WP-2690) at a concentration of 2 mg/l.

Having established the optimum in chemical clarification, the remainder of the composite sample was batch clarified with 2 mg/l of Calgon WP-2690. After settling, the suspended solids content of the supernatant liquor was 10 mg/l. The floc which was produced settled rapidly and appeared that it would present no unusual sludge handling problems.

Sludge Settling

As part of the clarifying operation, portions of the treated composite sample were used for settling rate studies. Portions of the treated (pH, polymer) composite waste were promptly transferred to each of three calibrated 20-liter Pyrex jars. The already formed floc was thus allowed to settle and the sludge settling rate was thus determined in triplicate. Settling rates of 0.65, 0.60 and 0.70 inch/minute were observed.

Adsorption Isotherm Study

Isotherms had previously been determined for RCI's Parshall flume waste. This type data, however, is sensitive to changes in sample characteristics. For this reason an additional isotherm was run on the final composite sample using Calgon's Filtrasorb 300 activated carbon.

In order to obtain isotherm data, a fixed volume of waste is contacted with a varying amount of pulverized carbon for a fixed time at a constant temperature. The weight of the organic contaminant removed per unit weight of carbon is plotted as a function of the concentration. This is known as the Freundlich isotherm.

The isotherm data in this case are expressed in terms of TOC removal. These data are presented in Table V-5. The isotherm plot is shown in Figure V-2.

Pilot Plant, General

The design of a full-scale plant utilizing granular carbon adsorption must be based on the results of a pilot plant test conducted on samples of the waste stream to be treated. In addition to establishing whether or not the treatment objective can be met by granular carbon adsorption, pilot plant data required to determine such critical design parameters as operational adsorption capacity, rate of carbon

Table V-5. WASTE TREATMENT, FREUNDLICH DATA

Type Carbon - FS-300 Sample Volume - 100 ml
Temperature - Ambient Agitation - 1 Hour

Weight Carbon (m)	Remaining TOC mg (c)	TOC adsorbed mg (x)	x/m (Calculated)
0 - Control	288 mg	-	(554)
0.05 gms	264 mg	24 mg	480 (473)
0.1 gms	219 mg	69 mg	690 -
0.5 gms	170 mg	118 mg	236
1.0 gms	153 mg	135 mg	135
2.0 gms	110 mg	178 mg	89 (97)
5.0 gms	74 mg	214 mg	43
10.0 gms	41 mg	247 mg	25

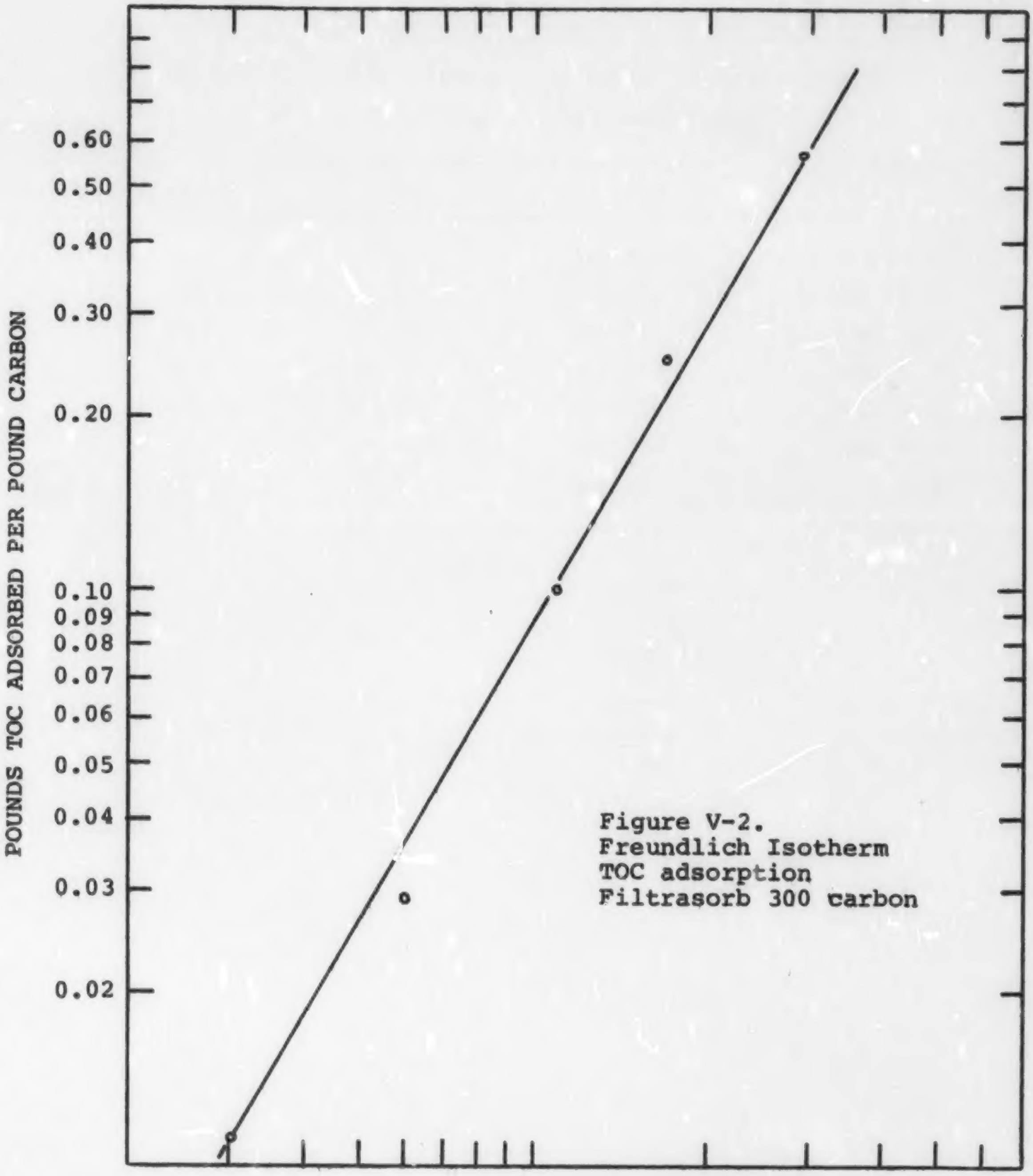


Figure V-2.
Freundlich Isotherm
TOC adsorption
Filtrasorb 300 carbon

exhaustion, optimum contact time and critical bed depth - the depth of the adsorption zone.

Pilot Plant, Description and Operation

Supernatant from the batch clarified final composite sample was pumped through six 1-inch diameter glass columns connected in series. The columns were filled with the following amounts of Calgon Filtrasorb 300 granular activated carbon:

Column #1	66 grams
Column #2	66 grams
Column #3	131 grams
Column #4	200 grams
Column #5	200 grams
Column #6	200 grams

The respective bed depths were as follows:

Column #1	1 ft
Column #2	1 ft
Column #3	2 ft
Column #4, #5, #6	3 ft each

The clarified supernatant was pumped through the columns at a flow rate of 20 ml/minute, giving 7.7 minutes of contact time for each foot of bed depth. Thus the total superficial contact time employed in the study was 100 minutes.

The effluent from each column was monitored for breakthrough of TOC and the pH was checked intermittently. The effluent from Columns #2 and #4 was also monitored for breakthrough of COD. The final effluent from Column #6 (at 100 minutes contact time) was also composited for analysis.

The TOC breakthrough data are presented in Table V-6. The COD data on the effluent from Columns #2 and #4 are shown in Table V-7. The analytical data on selected final effluent composite samples are given in Table V-8.

Table V-6. TOC BREAKTHROUGH DATA, PILOT RUN 1

Mls Throughput	Column 1 66 gms TOC	Column 1 66 gms pH	Column 2 66 gms TOC	Column 2 66 gms pH	Column 3 131 gms TOC	Column 3 131 gms pH	Column 4 200 gms TOC	Column 4 200 gms pH	Column 5 200 gms TOC	Column 5 200 gms pH	Column 6 200 gms TOC	Column 6 200 gms pH
Initial	185		90		75		60		45		30	
1000	660		340		285	8.8	270		210	8.8	155	8.8
2000	1260		465	10.2	310		275	8.8	270		245	8.8
6000	1685		1470	8.7	500	10.3	330	9.7	300	8.6	300	8.7
8000	1735	8.4	1585	8.6	875	9.4	370	10.7	315	8.3	320	8.7
10000	2010	8.3	1680	8.4	1350	8.8	420	10.7	360		325	8.3
12000	2055	8.3	1785	8.4	1605	8.7	560	10.4	370	10.7	330	8.3
14000	2130	8.2	1830	8.3	1680	8.6	900	9.7	390	10.8	350	10.1
16000	2130	8.2	1860	8.3								
28000												
30000	2290	8.0	2160	8.1	1755	8.2	1655	8.4	1595	8.5	1040	9.5
32000	2305	7.9	2235	8.1	1755	8.2	1640	8.3	1610	8.5	1270	9.2
34000	2345	7.9	2260	8.1	1805	8.2	1755	8.3	1610	8.4	1455	8.8
36000	2310	7.9	2200	8.1	1815	8.2	1695	9.2	1665	8.4	1560	8.7
38000	2370	7.9	2250	8.1	1800	8.2	1770	8.2			1605	8.6
71000	2445		2310		2265		1830		1750		1725	
73000	2475		2310		2265		1830		1750		1800	
77000			2295		2295		1875		1740		1800	
79000			2310		2250		1920					
80000			2310									
99000	2245		2400		2265		2130		1875		1750	
117000									1920		1815	
118000			2355		2265		2235					
127000									1950		1860	
128000			2400		2265		2190					
144000									2145		1845	
145000			2415		2340		2250					

Table V-7. COD BREAKTHROUGH DATA, PILOT RUN 1

Throughput (Milliliters)	Column 2 COD ppm	Column 2 TOC ppm	Column 4 COD ppm	Column 4 TOC ppm
1000			440	270
2000	1000	465		
4000	3000	1140	600	295
8000	4650	1585	750	370
12000	4750	1785	1300	560
14000	5100	1830	2140	900
30000	6300	2160	4850	1655
34000	6150	2260	4900	1755
38000	6350	2250	5800	1770
71000	6350	2310	5250	1830
77000	6600	2295	5350	1875
79000			5400	1920
80000	6650	2310		
99000	6800	2400	6050	2130
118000	6800	2355	6550	2235
128000	6800	2400	6550	2190
145000	6800	2415	6550	2250

Table V-8. TREATED WASTE CHARACTERISTICS, PILOT RUN 1
(all data in mg/1)

Sample	Column 6				
	Throughput	TOC	BOD_5	COD	Phenol
Final Composite	-	2880	1425	6745	650
Clarified	-	2490	-	-	640
Composite 1	0 - 6 liters	235	195	365	0.2
3	10 - 14 liters	320	450	600	0.2
4	14 - 28	500	550	1230	0.4
5	28 - 34 liters	1280	600	3500	-
6	34 - 41 liters	1440	535	4550	-
10	70 - 73 liters	1800	550	4900	1.5

Pilot Plant Breakthrough Results

The pattern of removal of organic impurities by granular carbon adsorption can be illustrated by plotting the concentration of contaminant in the effluent from the pilot plant columns versus the cumulative volume passed through each column. These plots are commonly known as breakthrough curves and are normally defined as the curve connecting the breakpoint with the point of total exhaustion.

The TOC and COD breakthrough curves developed in this study are shown in Figures V-3 and V-4 respectively. As can be noted, there was a rapid breakthrough of TOC from all columns initially to approximately 300 mg/l. The TOC in the effluent from Column #6, however, plateaued off at this point up through approximately 14 liters throughput. This indicates that an adsorption system can be designed to produce acceptable quality effluent.

An inspection of the breakthrough curves shows that a minimum of 100 minutes contact time is required to develop a plateau at an effluent of 300 mg/l TOC. For ease of operation, a longer contact time is recommended.

An analysis of the breakthrough curves shown in Figure V-3 reveals that the carbon exhaustion rate required to achieve the desired effluent quality is approximately 430 lbs/1,000 gallons. This figure is based on a calculation of the volume of waste treated by the columns and the quantity of carbon contained in the columns.

The calculated exhaustion rate of 430 lbs/1,000 gallons was considered impractical from an economic standpoint. For this reason, an in-depth survey was made of the various RCI production processes and the waste streams generated from them. This review indicated that several in-plant modifications could be made which would greatly reduce the organic strength of the total waste stream. This reduction would of course manifest itself in a more practical carbon exhaustion rate. To investigate this alternative, the required modifications were made on a temporary basis and samples of the resultant waste stream collected for testing.

A twenty-four-hour composite sample of the modified waste was clarified and the supernatant analyzed. Results of these analyses are listed below:

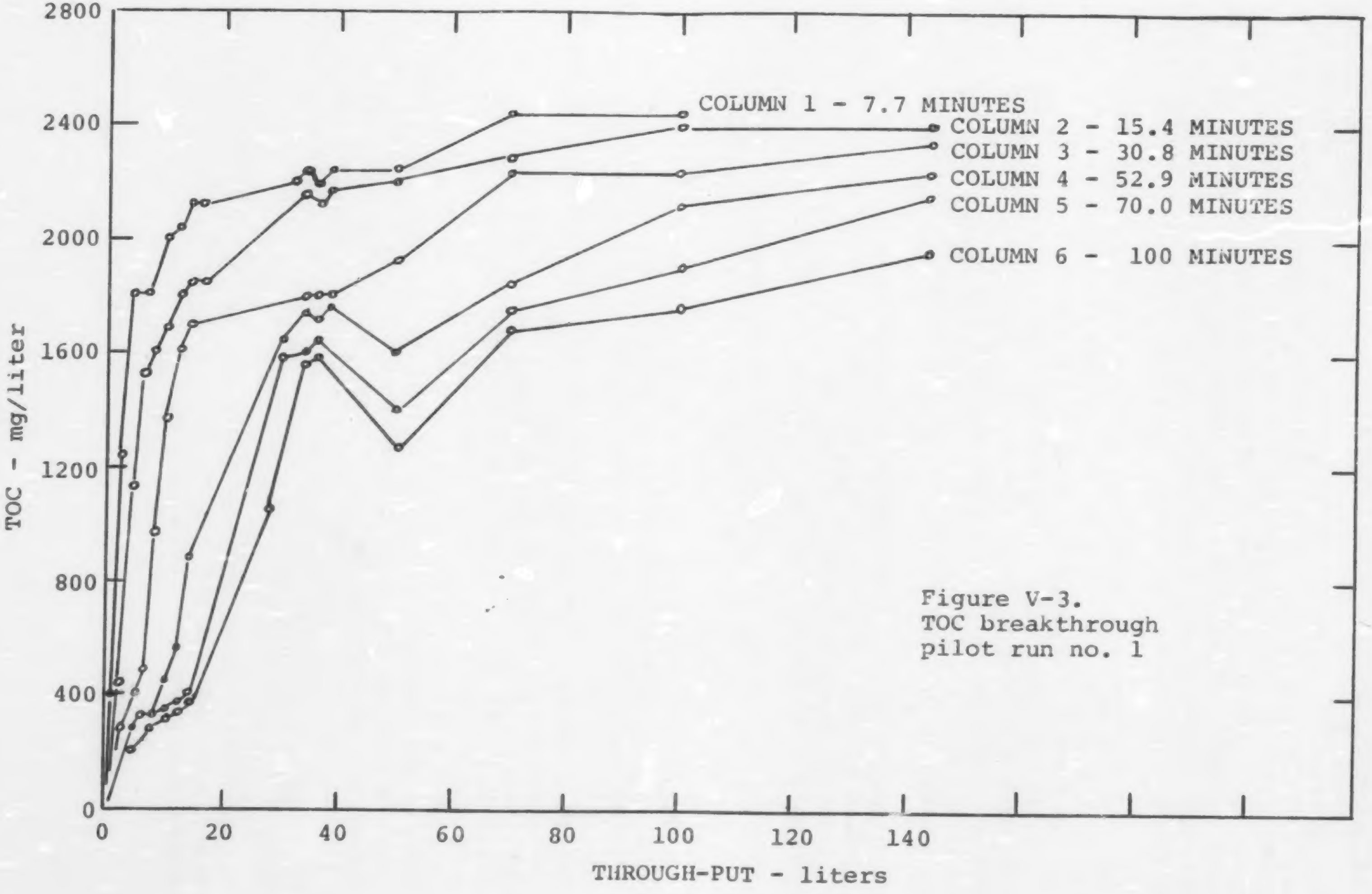


Figure V-3.
TOC breakthrough
pilot run no. 1

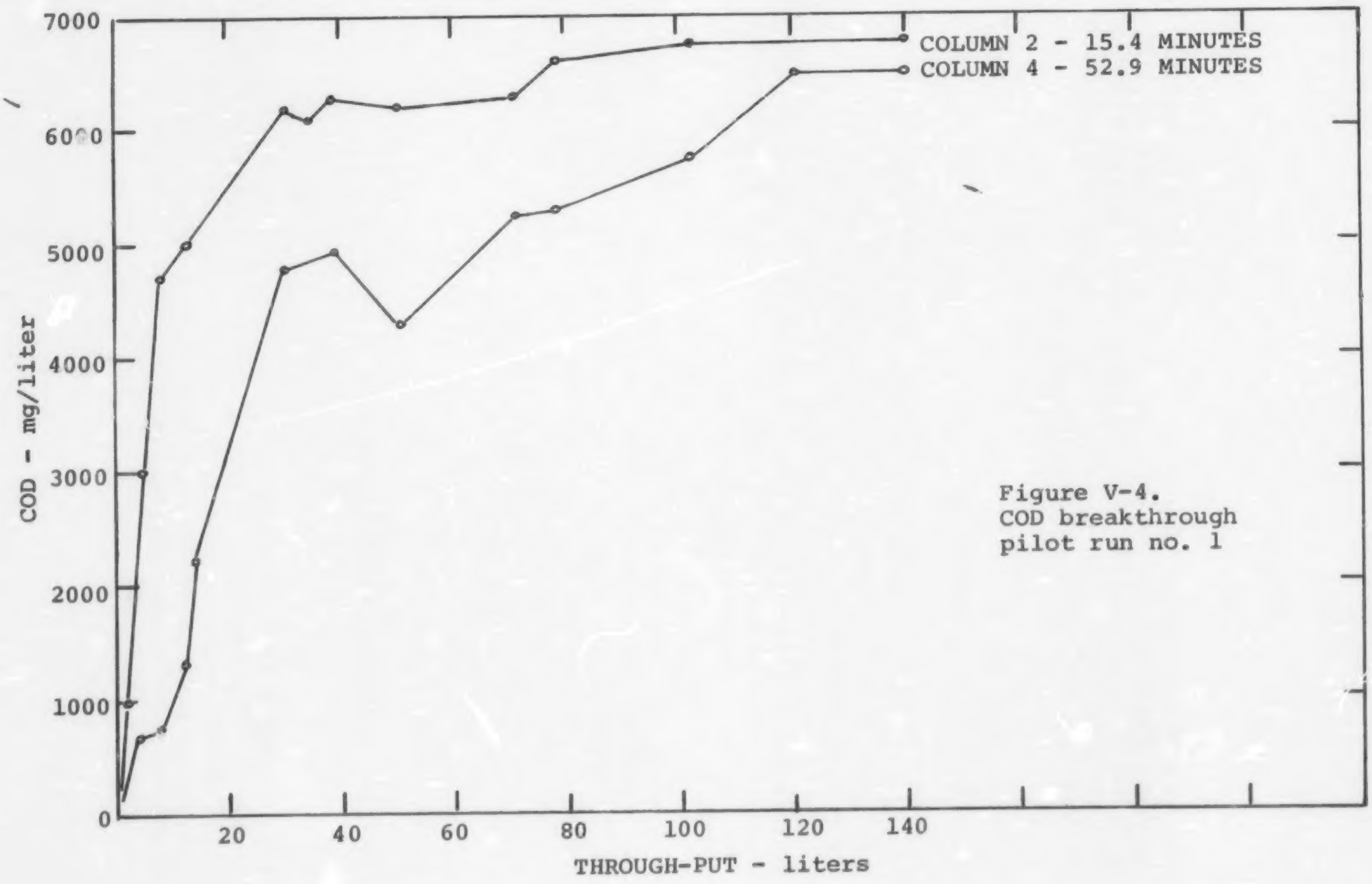


Figure V-4.
COD breakthrough
pilot run no. 1

TOC	575 mg/l
COD	1575 mg/l
Phenol	110 mg/l
SS	5 mg/l

The clarified waste sample was used as the feed stream for another pilot column study. This study was set up to provide a total superficial contact time of 150 minutes. The columns were filled with the following quantities of Filtrasorb 300 granular activated carbon:

Column #1	60 grams
Column #2	90 grams

The effluent from each column was monitored for breakthrough to TOC with periodic COD's performed on the effluent from the second column. These data are presented in Table V-9.

Analysis of this data by Calgon personnel reveals that the carbon exhaustion rate required to meet the treatment objectives for the modified waste stream is 36 lbs/ 1,000 gallons of waste.

A history of data on the modified waste indicates that the average COD concentration would be close to 2,850 mg/l, whereas the test COD was 1,575 mg/l. Using the ratio of these numbers as a correction factor, the design exhaustion rate is calculated to be 65 lbs/1,000 gallons of waste. It is important to note that although the in-plant modifications resulted in a roughly 50% reduction in the COD content of the waste, the selective elimination of poorly adsorbed compounds resulted in an 80% reduction in the carbon exhaustion rate.

PROPOSED PROCESS DESCRIPTION

Adsorption

A simplified flow diagram showing the proposed functional design of the physical chemical treating system for Parshall flume waste is shown in Figure V-5. As can be seen, the wastewater is to be clarified and then passed to granular carbon adsorption vessels for removal of dissolved

Table V-9. TOC BREAKTHROUGH DATA, PILOT RUN 2

Column 1		Column 2		
Throughput (Liters)	TOC	Throughput (Liters)	TOC	COD
0.36	110	0.50	65	-
0.72	130	2.24	140	-
1.08	140	2.55	140	-
1.80	145	3.02	145	-
2.16	150	4.84	150	230
2.52	155	17.58	150	275
2.88	165	25.32	150	-
3.96	170	27.8	150	260
6.48	175			
12.24	175	28.88	165	-
12.60	180	29.96	170	-
13.32	195	30.68	170	-
13.68	205	31.04	175	-
14.04	225	31.40	180	-
14.40	230	31.76	200	505
14.76	240	32.12	205	-
15.12	245	32.84	210	-
15.48	250	33.20	205	-
15.84	255	33.74	215	-
16.56	265	34.10	250	655
17.64	275	34.82	275	-
19.80	285	37.10	275	-
21.60	290			
23.76	300			
24.84	305			
25.56	310			
25.92	315			
32.64	315			
35.16	340			
37.50	375			

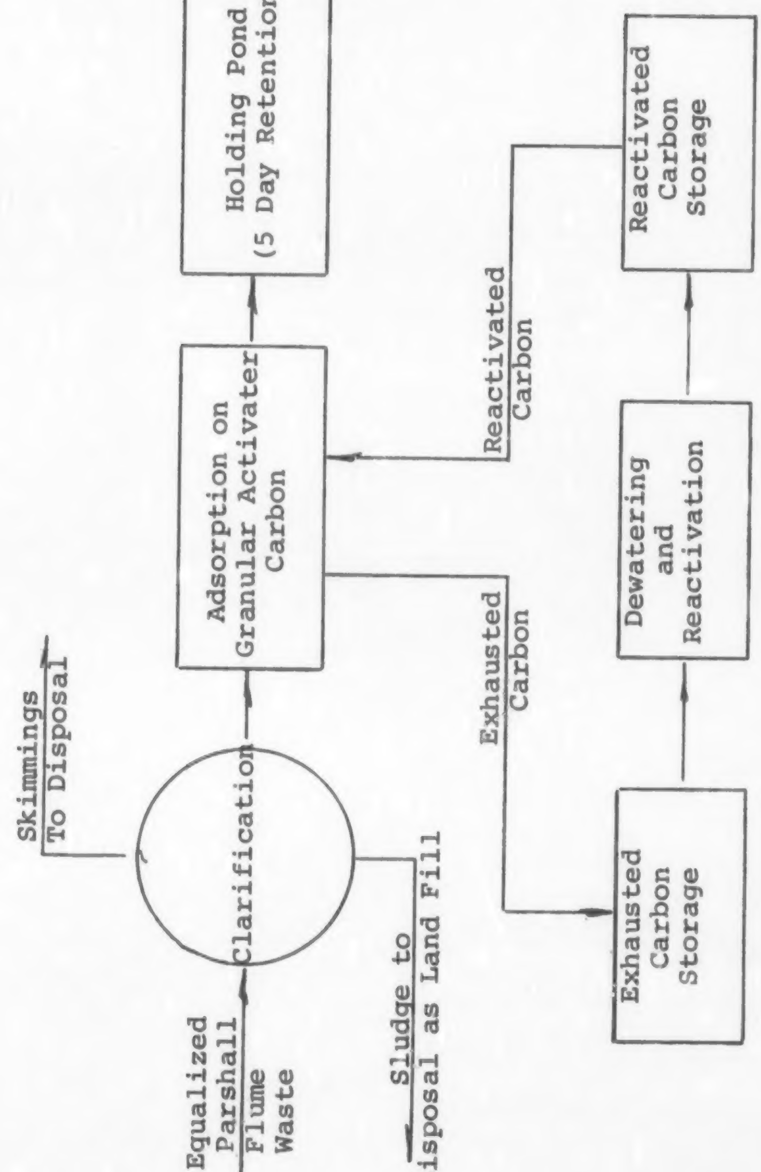

Equalized Parshall Flume Waste
Clarification
Skimmings To Disposal
Sludge to Disposal as Land Fill
Adsorption on Granular Activater Carbon
Holding Pond (5 Day Retention)
Discharge to River
Exhausted Carbon
Reactivated Carbon
Exhausted Carbon Storage
Dewatering and Reactivation
Reactivated Carbon Storage

Figure V-5.
Simplified flow diagram
Parshall flume waste treatment

organic impurities. The effluent from the carbon adsorption vessels then goes to a 5-day emergency holding pond before being ultimately discharged.

Adsorption will take place in two moving bed adsorbers which are operated in parallel. Each vessel will be designed on the basis of providing 100 minutes or more superficial contact time. Thus, sufficient contact time will be built into the system to ensure acceptable effluent quality.

The clarified wastewater enters the moving bed adsorbers near the bottom and flows upward, discharging at the top. The moving beds will be completely filled with granular carbon at all times. Organic impurities are adsorbed during this passage through the columns. Periodically spent carbon is discharged (slugged) from the bottom of each vessel and virgin or reactivated carbon is added at the top to replace it. The movement of the carbon is essentially countercurrent to the flow of wastewater through the adsorber. This places the most active carbon in contact with the more purified water and achieves maximum utilization of the carbon and maximum adsorption performance.

In this particular case, moving bed adsorbers with 100 minutes or more contact time will produce an effluent which meets the quality requirements tabulated in Section I. When the concentration of BOD_5, COD or phenol in the effluent approaches the concentration corresponding to the discharge unit the vessel will be slugged and virgin or reactivated carbon added at the top. In this way acceptable quality effluent will be obtained at all times.

Carbon Reactivation

Spent or exhausted activated carbon may be reactivated by either physical or chemical means depending on the nature of the adsorbed material and on whether the adsorbed material is or is not to be recovered.

Substantially completely exhausted carbon was available from the pilot column runs described previously in this section. Reactivation experiments were made using suitable portions of the well-mixed spent carbon.

Chemical reactivation by leaching or washing the spent carbon with practical concentrations of mineral acids (sulfuric and muriatic) was totally ineffective in restoring the carbon activity as measured by iodine adsorption.

Chemical reactivation by leaching or washing the spent carbon with dilute (5 or 10%) aqueous caustic soda (NaOH) solution was partially effective. The caustic solution removed the adsorbed phenol as sodium phenate but did not displace other adsorbed organic materials or so changed the carbon characteristics as to reduce its capacity to less than 50% of that of virgin carbon.

Since chemical reactivation appeared to be economically impracticable, the conditions for physical (thermal) reactivation were investigated.

Granular carbon is usually wet when fed to a reactivation furnace. The water concentration is a function of carbon size, temperature of water during the dewatering step, and amount of adsorbate on the carbon. In general, the concentration varies between 40 and 50 weight percent on a wet spent basis.

Since the carbon is wet, drying is the first step in the thermal reactivation process. During this step, it is also possible for volatile organics to be steam-distilled.

The second step has been termed "baking or pyrolysis" of the adsorbate and occurs in the temperature range from 212° F to 1500° F.

The third step is the activating process where the adsorbate and some of the carbon structure react with CO_2 and H_2O. The reactions are:

$$C + CO_2 \longrightarrow 2CO \qquad (1)$$

$$C + H_2O \longrightarrow CO + H_2 \qquad (2)$$

During activation, the temperature can be as high as 1900° F. The hot carbon leaving the furnace is quenched in water to 100° F and reused in the adsorption cycle.

Thus two reactivation variables need be determined - reactivation time and reactivation (furnace) temperature. Other pertinent data include (a) water content of the spent carbon, (b) amount of adsorbate in the spent carbon, (c) amount of fraction of the adsorbate which volatilizes, and (d) amount of steam required for equation (2) above.

The extent or degree of reaction of spent carbon is determined in one or both of two ways. The iodine adsorption value is an easily determined parameter that, when compared to the same value for the same virgin carbon, indicates the degree of reactivation although the numerical values obtained have no exact relation to the actual capacity of the carbon. The change in apparent density of the carbon, in consistent units, may also be used to monitor the regeneration of spent carbon. Since the adsorbate increases the weight of the carbon particles without increasing their volume, it is obvious that destroying or displacing the adsorbate effects a decrease in the weight of the carbon and consequently in the apparent density of the carbon.

Laboratory work included reactivation experiments involving different reactivation temperatures (see Table V-10 for typical results) and reactivation time. A typical laboratory experiment involved exposing seven (7) pairs of samples of spent carbon to reactivating temperature (1750° F) in a furnace for seven (7) increasing time intervals ranging from ten (10) to forty (40) minutes. The apparent density of these carbon samples is shown in Figure V-6 plotted against time. These data indicate that reactivation is complete in between thirty (30) and thirty-five (35) minutes in a furnace maintained at 1750° F. Evaluation of all laboratory reactivation data indicates that a minimum of thirty-two (32) minutes to a final temperature of 1750° F results in reactivation at the lowest temperature in the shortest time while holding carbon loss to a minimum. Note that the matter of carbon loss is covered in Section VI.

ENGINEERING CONSIDERATIONS

Introduction

This part presents the results of a preliminary engineering study of the waste treating process described in this section. The proposed process described herein includes steps of waste equalization, pH adjustment, coagulation,

Table V-10. APPARENT DENSITY OF REACTIVATED CARBON
(all data in gms/cc)

Reactivation Temperature	1600° F	1750° F	1900° F
Reactivation Time			
20	0.56	0.51	0.50
40	0.51	0.48	0.48
60	0.49	0.48	0.48

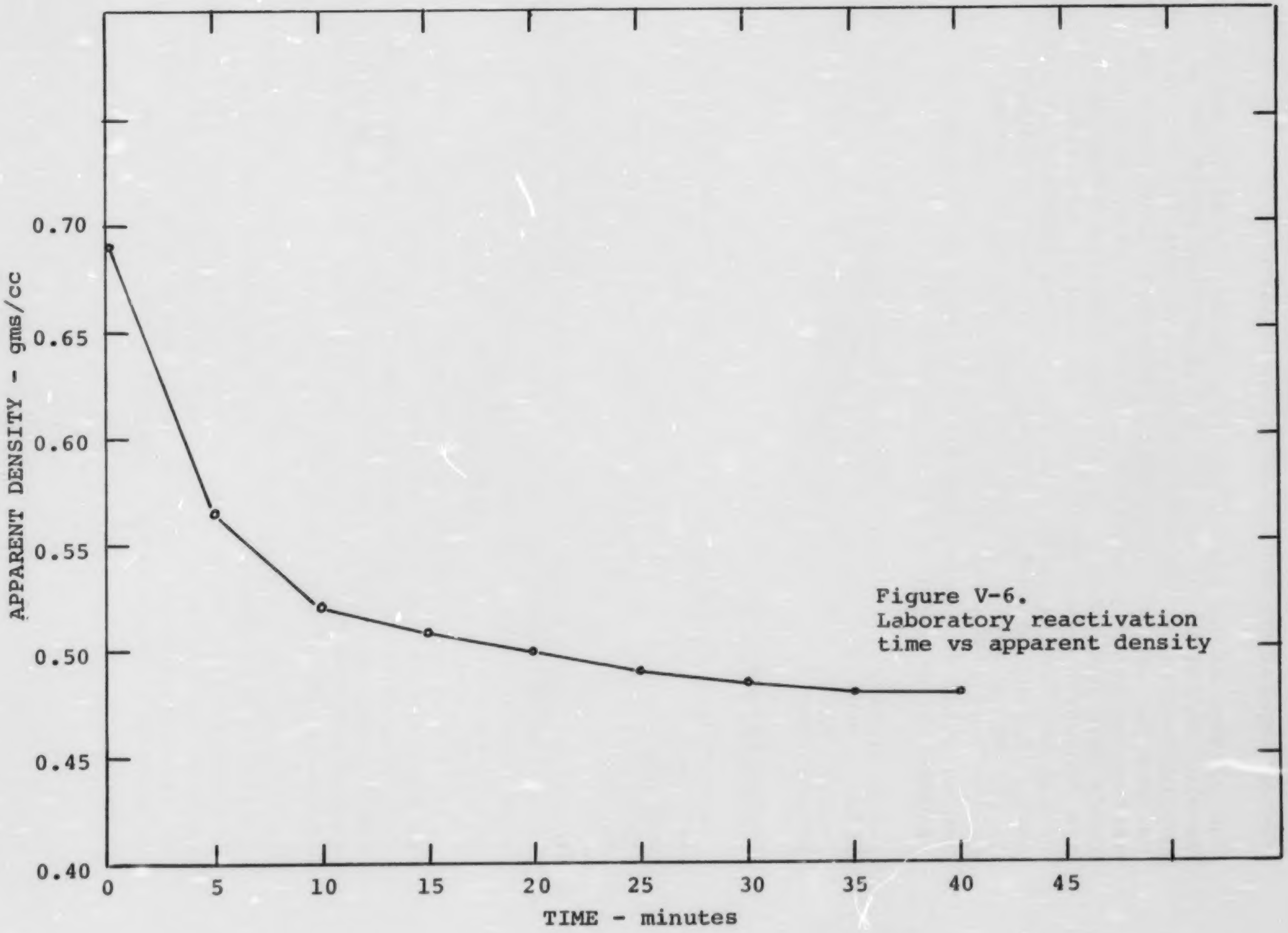


Figure V-6.
Laboratory reactivation
time vs apparent density

desimentation, adsorption of solutes on activated carbon, carbon separation and carbon reactivation.

The purpose of this preliminary engineering study was to develop estimates of capital and operating costs for a physical-chemical treatment system for treating 500,000 gallons per day of wastewater. Treatment objectives and wastewater quality criteria used in this study have already been presented. The capital costs presented here are estimates based on information readily available within the time allotted and are correct within ± 20 percent. Operating costs are based on the data developed in the Pilot work. Additional data will be collected before completing the final design to verify these results and to guide in optimizing the designing and operating parameters to reduce costs to a minimum.

Final disposal of sludge and skimmings and a five-day holding pond are required but are not included in this section since they have no direct bearing on the treating process per se.

Design Parameters

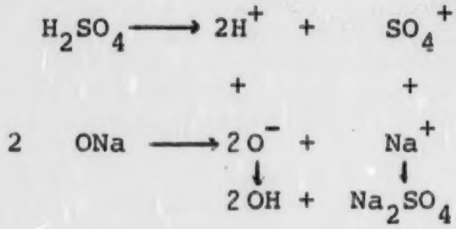
The Parshall flume wastewater treatment system developed is sized to treat 500,000 gallons per day of waste having characteristics as shown in Table III-1 of this report. Individual unit operations and systems are designed as follows:

Equalization--Because of the wide day-to-day variation in waste composition (see Table V-3), it was obvious that some degree of waste equalization would be desirable if not necessary. For example, if the high pH flow of May 13, 1971, could be mixed with the low pH flow of May 14, 1971, the corresponding neutralizing chemicals would not be required, since the two days' waste would substantially neutralize each other. Similarly if the high COD load of May 16, 1971, could be mixed with the lower COD load shown for May 15, 1971, the adsorber operation would certainly be vastly improved.

Examination of pH data for the Parshall flume waste stream indicated that about ninety (90) percent of the major fluctuations in waste composition could be equalized in a pond or vessel having a capacity equivalent to a minimum of two and one-half (2 1/2) days' waste flow. Obviously equalization means having greater capacity would be desirable. Actually the size of the equalization pond in excess of two and one-half (2 1/2) days' waste flow would be governed by ground space available and the economics of achieving a reasonable degree of mechanical mixing of the contents of the equalization pond. A pond having a holding capacity of two and one-half (2 1/2) days (1,250,000 gallons) at minimum operating level (agitation), three (3) days (1,500,000 gallons) at normal level, and four plus (4+) days (2,100,000 gallons) at overflow level should be specified.

Neutralization--A neutralization system for adjusting pH is required based on data presented in Table IV-1. Clarification and adsorption were found to be effective on a five-day composite sample at pH 8.0.

There are no firm criteria for establishing the holding or retention time for the waste liquor neutralization. The chemical reactions typically involved are very rapid--



$$\begin{array}{cccc} H_2SO_4 \longrightarrow & 2H^+ & + & SO_4^+ \\ & + & & + \\ 2\quad ONa \longrightarrow & 2O^- & + & Na^+ \\ & \downarrow & & \downarrow \\ & 2OH & + & Na_2SO_4 \end{array}$$

practically instantaneous. The retention time required, and consequently the size of the vessel required, is that needed to assure mixing of the chemical reagents with the liquid waste.

Since this vessel should be adjacent to or even a part of the clarifier, we specify a vessel providing a minimum of fifteen (15) minutes' retention time (5,200 gallons) and up to thirty (30) minutes' retention time consistent with the size and layout developed for the clarifier.

Provision is made to feed 3 pounds per minute of concentrated sulfuric acid and 0.5 gallon per minute of 50% sodium hydrozide. These figures are based on estimates and are subject to revision upon obtaining additional pH and neutralization data. Data from additional spot samples of waste indicate that the waste may actually be self-neutralizing.

A polyelectrolyte coagulant will be added in a second basin to provide for optimum suspended solids removal. The non-ionic, water-soluble coagulant (Calgon WT-2960) specified should be prepared as a 0.2% aqueous solution. Since only eight (8) pounds of coagulant is required per day, the use of more concentrated solutions is neither required nor practical from a measuring standpoint since approximately 20 g/hr of the solution needs be metered into the neutralized waste in the second basin.

Clarification--A clarifier is provided for removal of essentially all suspended solids and floating materials. It is equipped with sludge collection and skimming devices. It is designed for a nominal overflow rate of 500 gallons per day per square foot (500)gpd/ft^2).

From the sludge settling rate of 6 inches per 10 minutes reported previously, it follows that the clarifier overflow rate needs be slightly less than the sludge settling rate in order that the sludge will actually settle. Thus 6 inches/10 minutes X 60/12 X 7.5/24 = 540 gals./ft^2/day. Thus a nominal overflow rate of 500 gals./ft^2/day should be safe. Since the treating plant must handle 500,000 gallons of waste per day, the clarifier must be designed to provide 1,000 ft^2 of clarifying or settling area.

A flocculation zone is incorporated in the clarifier to improve sedimentation. The sludge handling system is designed to handle 5,000 gallons per day at 5 weight percent solids. Note that this concentration, while high for sanitary sludge, is not abnormal for industrial sludge. Sludge disposal will be by landfill and is not included in the scope of this project.

Adsorption--Although the Freundlich isotherm is a valuable tool for evaluating adsorption as a unit process, for comparing various adsorptive materials and for establishing process limits, it cannot, by itself, be used to define a workable process. For complex industrial wastes which exhibit multi-phase isotherms, a column study is required to define a carbon exhaustion rate. Evaluation of the TOC breakthrough curve shown as Figure V-3 indicates a practical figure to be 65 pounds per 1,000 gallons at a feed COD of 2,850 mg/l. Thus number is based on a COD limit of 640 mg/l and a TOC to COD ratio of 2.60. The process design is based on the following:

Flow Rate (Total)	350 gpm nominal
Number of Adsorbers	2
Flow Rate (Each Adsorber)	175 gpm nominal
Surface Loading	1.55 gpm/ft^2
Retention Time (Superficial	175 minutes

Reactivation--At a carbon exhaustion rate of 65 pounds/ 1,000 gallons, the calculated rate at which carbon must be reactivated is 32,500 pounds per day (1,350 pounds/ hour). The reactivation furnace will have a capacity slightly in excess of that rate to provide for peak days.

Process Description

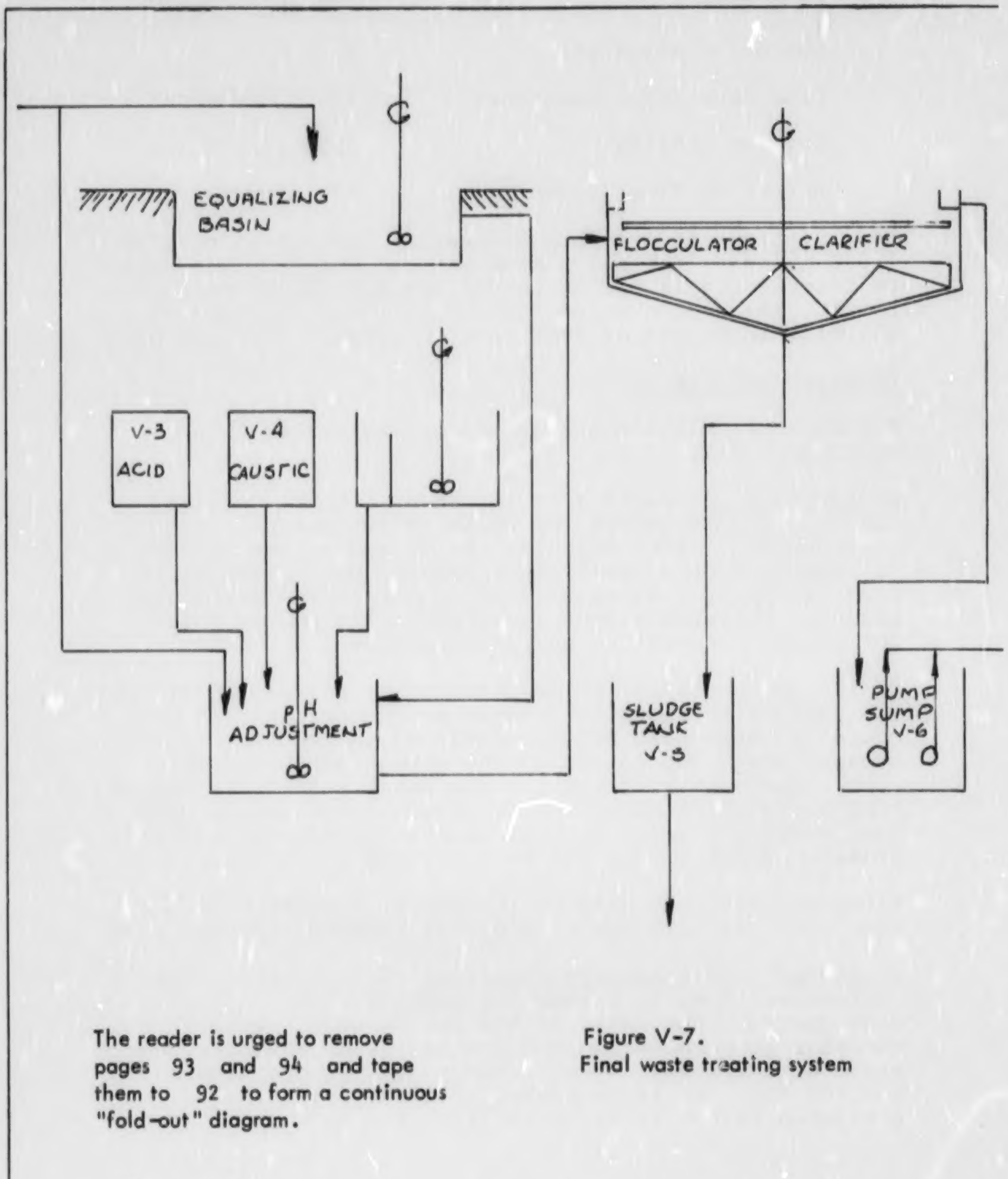
The Parshall flume wastewater treating system is shown in Figure V-7.

Neutralization--Wastewater is conveyed to the battery limits where it enters the first of two basins. A pH recorder/controller measures the pH and starts an acid or caustic pump to maintain a pre-set pH. A retention time of thirty (30) minutes is provided with mechanical mixing. Polyelectrolyte is added in the second basin for optimum removal of suspended solids.

Clarification--After pH adjustment and polymer addition, the wastewater flows to a 40-foot diameter clarifier where the suspended solids settle to the bottom. A scraper moves the solids to the sludge discharge for pumping to a holding tank at the battery limits. Solids removal from the clarifier is intermittent and is controlled by a timer. In this manner the solids concentration of the sludge can be optimized.

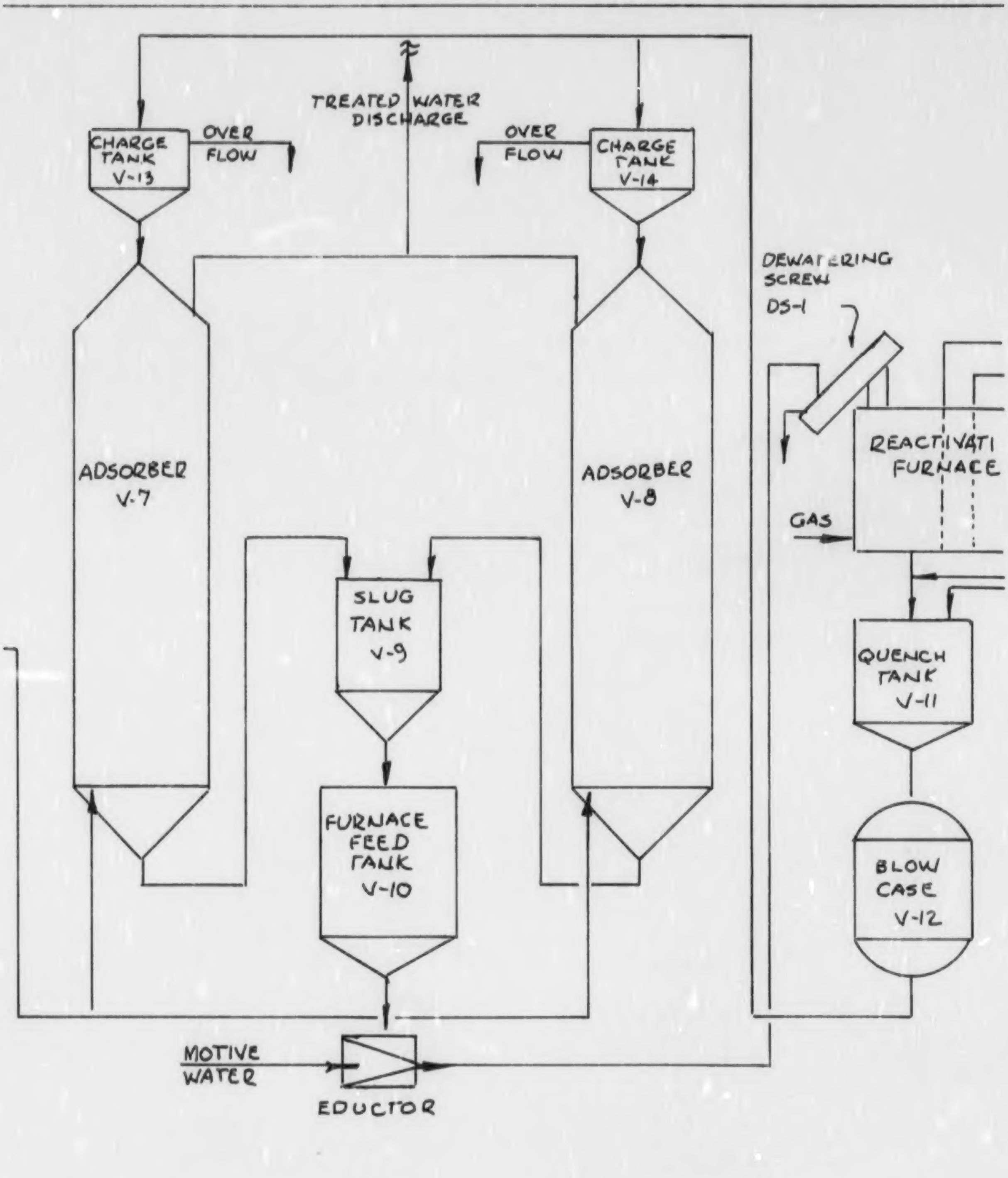
Floating materials will be removed by a skimmer to the scum sump for disposal outside the battery limits.

Activated Carbon Adsorption--After clarification, the wastewater flows to a sump for pumping to the adsorption system. The water enters two adsorbers through a circular pipe header at the bottom. Each adsorber consists of a circular steel-lined vessel with a cone bottom and top. It is completely filled with granular activated carbon (Filtrasorb 300 - 8 X 30 mesh).


EQUALIZING BASIN
FLOCCULATOR
CLARIFIER
V-3
ACID
V-4
CAUSTIC
pH ADJUSTMENT
SLUDGE TANK V-5
PUMP SUMP V-6

The reader is urged to remove pages 93 and 94 and tape them to 92 to form a continuous "fold-out" diagram.

Figure V-7.
Final waste treating system


TREATED WATER DISCHARGE
CHARGE TANK V-13
OVER FLOW
OVER FLOW
CHARGE TANK V-14
DEWATERING SCREW DS-1
ADSORBER V-7
ADSORBER V-8
REACTIVATI FURNACE
GAS
SLUG TANK V-9
QUENCH TANK V-11
FURNACE FEED TANK V-10
BLOW CASE V-12
MOTIVE WATER
EDUCTOR

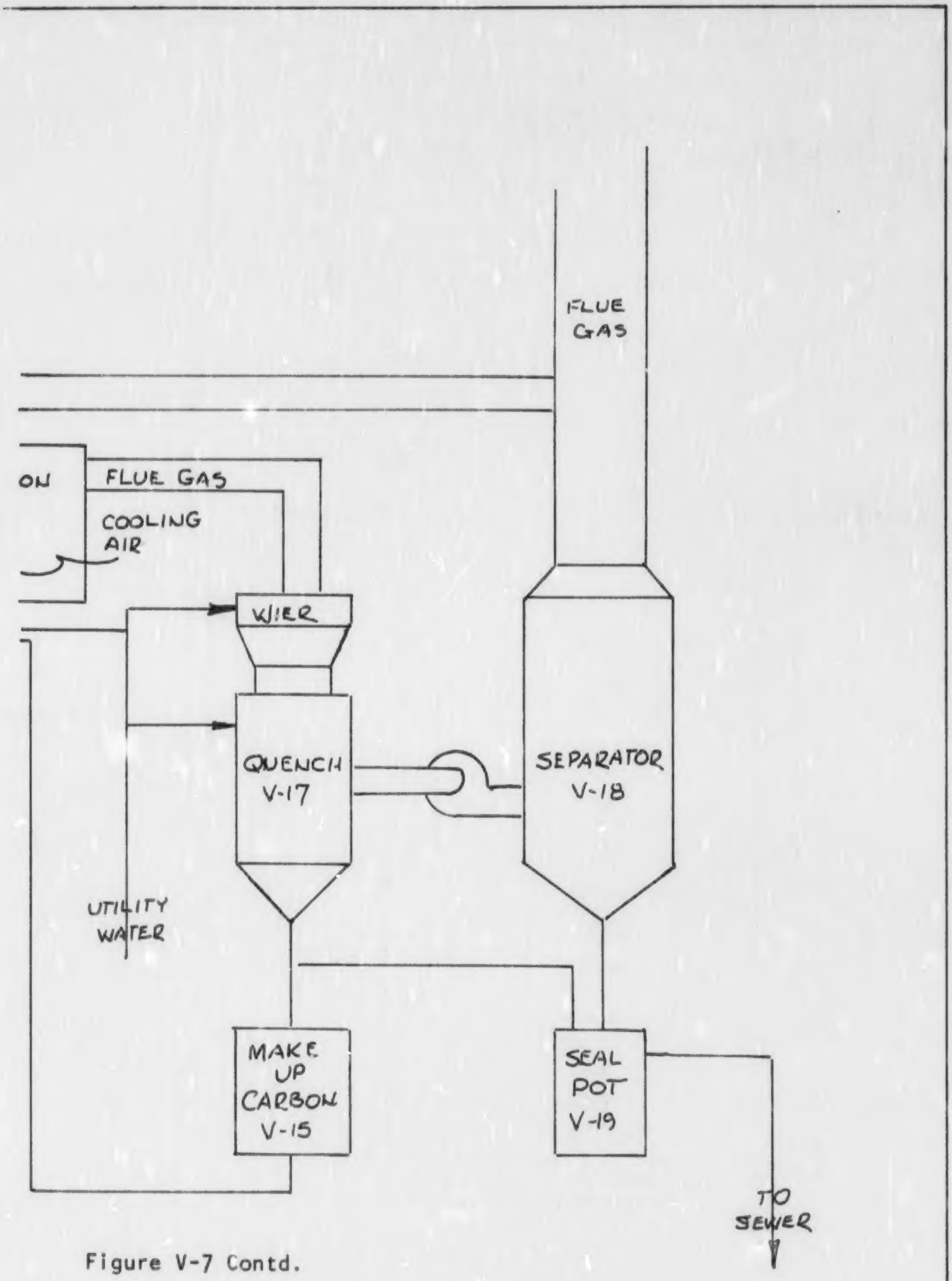

FLUE
GAS
ON
FLUE GAS
COOLING
AIR
WIER
QUENCH
V-17
SEPARATOR
V-18
UTILITY
WATER
MAKE
UP
CARBON
V-15
SEAL
POT
V-19
TO
SEWER

Figure V-7 Contd.

The two adsorbers are operated in parallel. The wastewater flows upward through the carbon beds and dissolved organic materials are physically adsorbed onto the surface of the carbon granules. With time the carbon becomes "spent" with respect to the effluent specifications. The carbon at the bottom of the bed is most heavily loaded with organics because the concentration of waste organics at that level is greatest. That portion of the carbon which is spent is removed periodically and fresh carbon added at the top.

This addition and removal will be accomplished by "slugging" (removing and adding increments of carbon) each adsorber approximately once each shift. One slug volume is approximately 200 cubic feet.

During the slugging operation, a valve at the bottom of the adsorber is opened allowing a slurry of carbon to flow to the slug measuring tank. Simultaneously, a valve at the top is opened allowing fresh carbon to flow from the charge tank to the adsorber. When the slug measuring tank is full, both valves are again closed and the slugging operation is complete. The contents of the slug measuring tank are then transferred by gravity to the furnace feed tank.

Carbon Transfer and Reactivation--Spent carbon is transferred by an education system from the furnace feed tank to a dewatering screw conveyor. Rate of carbon flow is regulated by a timer-operated ball valve.

In the dewatering screw conveyor, carbon is moved upward by an inclined screw conveyor and the water overflows to a drain. The upper end of the dewatering screw discharges into a reactivation furnace.

The reactivation furnace is a multiple-hearth type, 13 ft, 6 in. OD y with 5 hearths. A central rotating shaft with rabble arms at each hearth moves the carbon across the hearths and through drop holes causing it to pass through the furnace. As it passes through the furnace, the carbon is dried, organics are burned, and the pore structures are reestablished as it is reactivated. Normal operating temperature on the fired hearths normally range from 1650 - 1800° F.

Reactivated carbon is discharged to a water-filled tank where it is quenched. From there it drops into a blowcase for transfer to the adsorber charge tanks. Transfer is accomplished by closing the inlet ball valve and opening the transfer water valve and discharge valve. The blow case empties rapidly and transfer is complete.

EQUIPMENT DESCRIPTION

The following constitutes a listing and description of the major items of equipment needed to treat the Parshall flume waste according to the treating process outlined previously under "Proposed Process Description."

(1) Polymer Dissolving Tank (PF-1)

Function: To dissolve dry polymer in water and feed the resulting solution at a controlled rate.

Number Required: One

Solution Capacity: 400 gallons

(2) Clarifier (CF-1)

Function: To provide solids removal by gravity sedimentation.

Number Required: One

Overflow Rate: 500 gallons/day/ft^2

Basin Material: Reinforced concrete

(3) pH Adjusting Basin (V-1)

Function: To mix acid or caustic with the water to maintain constant pH.

Number Required: One

Capacity: 5,250

Size: 11 ft X 11 ft X 8 ft deep

Material: Reinforced concrete

(4) Acid Storage Tank (V-3)

Function: To provide storage of sulfuric acid for pH adjustment.

Number Required: One

Capacity: 6,000 gallons

Material: FRP or equal

(5) Caustic Storage Tank (V-4)

Function: To store caustic soda (50% NaOH) for pH adjustment.

Number Required: One

Capacity: 12,000 gallons

Material: FRP or equal

(6) Sludge Holding Tank (V-5)

Function: To receive sludge and store it for disposal.

Number Required: One

Capacity: 5,000 gallons

Material: Lined carbon steel

(7) Pump Sump (V-6)

Function: To receive clarified wastewater from (2).

Number Required: One

Capacity: 21,000 gallons

Size: 12 ft X 24 ft X 12 ft deep

Material: Reinforced concrete

(8) Moving Bed Adsorber (V-7 and V-8)

Function:	To adsorb organic materials from the wastewater stream.
Number Required:	Two in parallel
Size:	12 ft diameter X 36 ft straightside with 67° cone bottom and 45° cone top
Capacity:	250,000 gallons per day at 1.6 gpm/ft^2; carbon holding capacity of 4,360 cubic feet of Filtrasorb 300 (145,000 pounds) each
Material:	Epoxy-phenolic lined carbon steel

(9) Slug Measuring Tank (V-9)

Function:	To receive and measure one slug volume of spent carbon.
Number Required:	One
Capacity:	200 cubic feet
Size:	6 ft 0 in. ID X 7 ft 0 in. straightside with 45° cone bottom
Material:	Epoxy-phenolic lined carbon steel

(10) Furnace Feed Tank (V-10)

Function:	To receive and hold spent carbon from the slug measuring tank for feed to the furnace.
Number Required:	One

Capacity: 1,200 cubic feet

Size: 12 ft diameter X 12 ft straightside, slant bottom

Material: FRP or equal

(11) Quench Tank (V-11)

Function: To receive and cool hot reactivated carbon.

Number Required: One

Capacity: 200 cubic feet

Size: 6 ft 0 in. ID X 7 ft 0 in. Straightside with 45° cone bottom

Material: 304-L stainless steel

(12) Blowcase (V-12)

Function: To transfer quenched carbon to the charge tanks.

Number: One

Size: 3 ft 6 in. ID X 3 ft 6 in. straightside with dished top and bottom

Material: 304-L stainless steel

(13) Charge Tanks (V-13 and V-14)

Function: To hold reactivated carbon for charging into the carbon columns.

Number: Two

Capacity: 400 cubic feet each

Size: 8 ft 0 in. ID X 8 ft 0 in. straightside with 45° cone bottom

Material: Epoxy-lined carbon steel

(14) Makeup Carbon Storage (V-15)

Function: To receive and store fresh carbon for makeup.

Number: One

Capacity: 50,000 pounds of Filtrasorb 300

Size: 12 ft 0 in. ID X 16 ft 0 in. straightside with slant bottom

Material: FRP or equal

(15) Reactivation Furnace F-1

Function: To reactivate spent carbon.

Size: 13 ft 6 in. ID X 5 hearth with integral afterburner

Capacity: 32,500 pounds/day of spent carbon

Description: Unit is a refractory-lined steel shell with 5 hearths of refractory tiles. An air-cooled rotating shaft extends vertically through the center of the furnace. Rabble arms and teeth are connected to the shaft at each hearth level.

COST ESTIMATES

Capital

The estimated cost, as of 1971, to install the facilities described here and shown on the flow sheets is indicated below. This is a preliminary estimate based on preliminary material take-off plus vendor pricing of the furnace. The estimated cost shown here includes:

A. Direct cost for all facilities including foundations, electrical, painting, and all other material and labor required to erect the facilities.

B. Indirect costs for field supervision, craft fringe benefits, engineering, and all other contractor overhead.

C. Fee and profit for contractors.

The accuracy of the cost figures presented is estimated at ±20%.

	Capital Cost
Pretreatment	$220,000
Adsorption	
Initial Carbon Fill	75,000
Adsorbers and Carbon Handling	225,000
Reactivation Package	320,000
Subtotal	$810,000
Engineering and Procurement	90,000
Total	$900,000

Operating

The operating costs, as of 1971, for this system are primarily controlled by the rate of carbon reactivation. The bases used in calculating operating costs are as follows:

pH Adjustment Chemicals--The need for both acid and caustic addition was discussed earlier. The required amount of each as shown is based on estimates. It is likely that sufficient equalization would substantially reduce the amount of neutralization chemicals needed.

Sulfuric Acid:

Requirement (average)	8.7 lbs/1000 gallons (4350 lbs/day)

Cost at $0.02/lb	$87/day

Sodium Hydroxide:

Requirement (average)	17 lbs/1000 gallons
Cost at $0.035/lb (50% solution)	$295/day

Since neutralization will require each chemical approximately 50% of the time, the estimated cost is:

($87 + $295) X 1/2 = $191/day

Polymer--Using 2 mg/l of Calgon polymer WT-2690, the cost for polymer is $17.54/day.

Makeup Carbon--The following estimated cost of makeup carbon is based on a loss of 5% on reactivation. In a well operated system, the losses may be held to about 3.5%.

Carbon Reactivated	32,500 lbs/day at 65 lbs/1000 gallons
Makeup Carbon at 5%	1625 lbs/day
Cost at $0.30/lb	$488/day

With losses at 3.5%, the above cost is $342.

Maintenance--Maintenance requirements on this system should be very minimal. An average cost of $38/day is suggested for maintenance.

Utilities--

Power:

Reactivation System	900 kwh/day
Clarification and Sludge Pumping	700 kwh/day
Total	1600 kwh/day

At $0.01/kwh, the cost for power is $16/day.

Fuel Gas:

For the reactivation and furnace and afterburner, approximately 6,000 Btu per pound of carbon reactivated are required. Reactivating 32,500 lbs/day with gas at 1000 Btu/ft^3, 195,000 ft^3/day of gas is required. Cost for gas at \$0.50 per cubic foot is \$97.50/day.

Operating Cost Summary--

Pretreatment:

Acid and Caustic	$191/day	
Polymer	18/day	
Power	7/day	
Maintenance	11/day	
Total	$227/day	

Carbon Reactivation and Makeup:

Makeup Carbon	$488/day	($342)*
Gas	97/day	
Power	9/day	
Maintenance	27/day	
Total	$621/day	($475)*

*3 1/2% reactivation losses.

Note that the foregoing capital and operating costs do not include the cost of facilities or personnel required to perform the water testing needed to optimize the treating plant operations. It is recommended that all water testing, whether or not directly related to operation of the facility, be consolidated at one location. Such consolidation is certain to achieve both capital and operating economics. A study leading to such a consolidation is not within the scope of the work reported herein, hence no attempt has been made to include laboratory and testing costs in the above estimates.

SECTION VI

WASTE TREATING PLANT OPERATIONS AND PERFORMANCE

DESIGN MODIFICATIONS

A wastewater treating plant (see Figure V-7) has been built and is in operation at the Tuscaloosa, Alabama, plant of Reichhold Chemicals, Inc. This treating plant employs an adsorption process substantially identical to that illustrated in Figure V-5.

Operations are briefly described and performance of the plant is summarized in this section. Complete, day-by-day performance data for a typical, six-month period of operations are provided in Appendix B.

Certain minor differences exist between the treating process now in operation and the original process proposed in Section V and shown in Figure V-7. These differences are as follows:

Referring to Figure V-7, piping that would permit feed of wastewater directly to pH adjustment vessel, thus bypassing the equalization basis, does not now exist. Further, and still referring to Figure V-7, it has been found that caustic for pH adjustment was not normally required. For this reason Caustic Tank "V-4" was not installed. In the event of an emergency requiring the addition of caustic to the wastewater, this could and would be accomplished by deliberately introducing commercial 50% caustic solution to the system via one of several of the waste streams shown in Figure III-2. Facilities now permit use of the reactivation furnace cooling air as preheated combustion air for the afterburner section of the reactivation furnace. Too, it has been found necessary to return the water overflowing from the seal pot (V-19) to the clarifier rather than discharging it to the sewer as indicated since this water occasionally contains more absorbed phenol than can safely be discharged.

OPERATIONS DESCRIPTION

Since no two wastewater treating plants will ever be exactly identical, it is felt that inclusion of detailed operating instructions and procedures in this report would not only be unnecessary but actually confusing. The following brief description will, however, serve to broadly acquaint production and engineering personnel with the operations and problems inherent in a carbon adsorption waste treating facility.

Waste water from various plant drains enters the equalization basin through the Parshall flume. Complete mixing of these streams is accomplished during the residence time in the basin by means of four turbine type agitators. The waste water is transferred to an acid mixing chamber by means of waste water feed pumps. Sulfuric acid is added to the waste water in this chamber which is mixed by means of a turbine type agitator. A non-ionic polymer is added to the neutralized waste water as it leaves the acid mixing chamber. The waste water then flows by gravity to a flocculation chamber where a flocculator mechanism promotes the floc formation. The waste water then flows by gravity to the clarifier where the solids settle out of the waste stream. The clarified stream leaves the clarifier through a launder encircling the clarifier tank and flows to the adsorber feed pump sump. A clarifier mechanism is employed to collect the settled solids. This solids laden stream is withdrawn from the clarifier bottom sump by a pump which discharges the stream into the thickener. Further separation of solids from the waste stream is accomplished in the thickener by means of a thickener mechanism. The supernatant flows by gravity from the thickener collection launder back to the equalization basin where it is mixed with the incoming waste streams. The thickened solids are withdrawn from the solids sump by a pump and is trucked to a land-fill pit.

The sulfuric acid system, consisting of a horizontal storage tank (V-3), an acid unloading station, an acid overflow neutralization sump, and a metering pump, is provided for the purpose of transferring the desired amount of acid from storage to the waste water in the mixing chamber.

The BPF-400 polymer feed system (PF-1), consisting of a feed hopper, vibrator type feeder, polymer mixing (dissolving) tank complete with agitator, polymer solution pump for transferring the solution to the storage tank and a variable capacity pump for feeding the solution to a mixing type eductor, is provided for feeding the desired polymer solution to the waste water at the outlet of the acid mixing chamber.

Clarified waste water is transferred from the feed pump sump in the pre-treatment area to the moving bed adsorbers (V-7 and V-8) by feed pumps. The organic impurities present in the waste water are adsorbed on the activated carbon as the water is passed through the columns.

The treated water leaves the adsorbers and flows by gravity to a treated water tank not shown in Figure V-7. The overflow from the tank flows to the Warrior River, to the holding basin, or to the equalization basin for reprocessing if necessary. Treated water pumps take suction from this tank and provide a source of water for eductors, scrubber and hose stations.

Spent carbon is removed (slugged) approximately once every 8 hours from each adsorber by gravity. This carbon, in slurry form, flows to the slug measuring tank (V-9) from which it is drained into the furnace feed tank (V-10). The spent carbon is transferred from this tank as a slurry by an eductor which discharges it into a 12" diameter dewatering screw (DS-1). The carbon transfer rate is controlled by intermittently opening and closing a timer-operated ball valve on the bottom of the furnace feed tank. The timer controls the frequency of the valve operation. In the dewatering screw, excess water drains from the carbon and overflows back to the furnace feed tank. The drained carbon containing approximately 50% water on a wet basis flows by gravity from the elevated end of the dewatering screw through a chute onto the No. 1 hearth of the reactivation furnace.

In the furnace, the carbon is first dried and then stripped of its adsorbed impurities by a countercurrent flow of gases and returned to near virgin activity. The carbon is moved from hearth to hearth by the action of the rabble arms which "plow" the carbon across the hearths. The reactivated carbon discharges from the bottom of the furnace into the quench tank (V-11) where it is quenched and cooled with water. The reactivation furnace is equipped with an afterburner and scrubbing system to eliminate any odor-causing impurities and particulates in the off-gas stream.

Fuel for the burners in the furnace is natural gas with diluted LPG used on a stand-by basis.

The cooled reactivated carbon is intermittently discharged by gravity from the quench tank to the blowcase (V-12). It is then transferred as a slurry to the adsorber charge tanks (V-13 and V-14) by pressurizing the blowcase with plant air.

During reactivation and handling of the carbon, small losses occur. These are replaced by virgin carbon which is held in reserve in the make-up carbon storage tank (V-17). The carbon is transferred as a slurry from this tank to the quench tank as required.

WASTE PRETREATMENT

The waste water from the chemical plant is collected in the plant and run through a 36" diameter main to the equalization basin in the pretreatment area. This basin is an open reservoir having a normal capacity of 1,250,000 gallons at a depth of 6' and a capacity of approximately 3,000,000 gallons at its maximum depth of 12'. It contains four vertical turbine type agitators and two vertical turbine type centrifugal pumps. The basin is provided for the purpose of furnishing waste water holdup capacity and for the purpose of obtaining complete mixing of the various waste streams which have been gathered together in the chemical plant and sent to the adsorption plant for treatment.

Waste water is pumped from the basin into the acid mixing chamber. The plant flow rate is controlled at this point by a magnetic type flow meter. The acid mixing chamber is provided to reduce pH by the addition of sulfuric acid before the addition of the polymer solution. The waste stream pH is controlled by the pH controller which regulates the flow from the acid system metering pump. The polymer solution flow rate is set at a predetermined rate and remains constant. The polymer solution is added at the outlet of the acid mixing chamber.

The sulfuric acid system will receive acid by tank truck.

The polymer system will receive polymer in bags which will be emptied into the feed hopper as required for solution make-up. The properly prepared solution is fed from the storage tank to the acid mixing chamber for blending into the waste water by the proportioning pump and dilution eductor.

Waste water flows into the flocculation chamber by gravity from the acid mixing chamber. The flocculator gently agitates the waste water to enhance the formation of large floc particles.

Waste water enters the clarifier through the rotating center feedwell and then flows outward through the area being swept by the slowly rotating mechanism as the solids are settled out of the waste. The clarified liquid flows out through an effluent launder encircling the tank and is discharged into the adsorber feed sump (V-6). The solids which have settled out are squeegeed off the tank bottom by the mechanism and collected in a solids sump at the center of the tank. These solids are then trucked as slurry to a land-fill pit.

The clarified waste water which has entered the adsorber feed sump is then fed to the moving bed adsorbers by feed pumps for final treatment.

CARBON ADSORBERS

The two adsorbers (V-7 and V-8) are mild steel vessels with conical top and bottom heads and are lined with Ceilcote Flakeline 103, a polyester resin based material. Each vessel will be completely filled with approximately 124,000 lbs. of Filtrasorb 300 granular activated carbon. The waste water enters the adsorbers near the bottom and flows upward through the carbon to the top cone where it discharges.

Once each shift spent carbon is discharged (slugged) from the bottom of each adsorber column and reactivated carbon is added at the top of the column to replace it. The slugging operation consists in opening the remotely operated slug value at the bottom of one or the other adsorber, thus allowing a slurry of spent carbon to fill the slug measuring tank (V-9). Simultaneously the valve between the adsorber being slugged and its charge tank (V-13 or V-14) is opened thus allowing an equal volume of a slurry of reactivated carbon to replace the spent material. During slugging the feed to the columns is reduced or shut off completely to insure that the adsorbers can be filled with fresh carbon from the charge tanks.

By using this slugging operation the movement of carbon is essentially countercurrent to the flow of waste water through the adsorbers since this places the most active carbon in contact with the most purified water thereby achieving maximum utilization of the carbon and optimum adsorber performance.

FURNACE FEED SYSTEM

When the slug measuring tank is full, it is then discharged into the furnace feed tank (V-10) by opening a remotely controlled drain valve in the bottom outlet line. A 2 1/2" eductor is used to transfer the carbon slurry from the furnace feed tank to the 304 stainless steel dewatering screw (DS-1). Motive water flowing through a venturi nozzle in the eductor pulls the carbon slurry into the eductor.

The carbon is metered from the tank to the dewatering screw by intermittently opening and closing the air-operated valve on the bottom of the tank. A timer controls the frequency of opening and closing.

The carbon in the slurry settles out in the pool in the feed end of the motor-driven dewatering screw located on top of the furnace. The dewatering screw is set at an angle so that the water drains countercurrent to the flow of carbon. The drained carbon discharging into the furnace will contain approximately 50 wt% water (wet basis). The excess water overflows from the dewatering screw to the furnace feed tank. The dewatered carbon flows by gravity from the elevated end of the dewatering screw through a chute onto the No. 1 hearth of the reactivation furnace.

REACTIVATION FURNACE

In the reactivation furnace, damp carbon is fed at a controlled rate onto the No. 1 hearth. It by-passes the top "zero" hearth, which serves as an internal afterburner. It is then moved downward over five additional hearths by rotating arms having rabble teeth that "plow" the bed of carbon. As the carbon moves downward it is first dried, then reactivated to near virgin activity. The reactivated carbon, at red heat, drops from the bottom of the furnace into the quench tank (V-11) which is full of water.

The furnace is fired with natural gas and the atmosphere is further controlled by the supplemental addition of steam. The gases generated at the hearths move upward through the furnace countercurrent to the carbon.

The carbon is reactivated by controlled oxidation of the impurities from the pores of the granules. Correctly reactivated carbon has nearly the same pore structure and physical and chemical properties as virgin activated carbon.

Due to rounding off of the granules, the particle diameter of reactivated "service" carbon is generally slightly less than that of virgin carbon. The apparent density usually is increased slightly. The molasses number is increased somewhat and the iodine number decreased. The ash content is gradually increased with extended use.

In the hot reactivation portion of the furnace, the water vapor and carbon dioxide in the furnace atmosphere selectively oxidize the impurities in the carbon pores. These oxidizing gases are reduced, by the impurities, to hydrogen and carbon monoxide which are themselves re-oxidized by air in the gas space above the carbon. Thus, the controlled mild oxidation of the impurities requires control of the furnace temperature and of the atmosphere in contact with the carbon. This, in turn, requires the addition of excess air and additional water vapor to maintain the correct conditions.

CARBON QUENCHING AND TRANSFER

In this system the hot reactivated carbon from the furnace is quenched in water to reduce the temperature and to wet the granules. The carbon-water slurry thus produced then flows through the reactivated carbon system to the adsorber charge tanks where it is used for slugging the adsorbers as required.

The hot reactivated carbon discharges down a chute from the furnace in small slugs as the rabble arms pass the drop hole on the bottom hearth. Flow is into the quench tank (V-11) where the chute extends into the water to form a gas seal to prevent air from being drawn into the furnace. A sampling nozzle in the chute permits taking hot, dry carbon samples.

The carbon slurry flows by gravity from the bottom of the quench tank to the blowcase (V-12). The slurry of reactivated carbon received from the quench tank is intermittently blown (once every 30 minutes, or otherwise, depending upon the cycle being used) to alternate carbon charge tanks (V-12 and V-14).

MAKE-UP CARBON

Virgin carbon must be added to the system periodically to replace losses. The need for make-up is indicated by observing the level of carbon stored in the furnace feed tank (V-10), the charge tanks (V-13 and V-14), and the quench tank (V-11).

The make-up carbon is delivered by truck and is transferred as a carbon-water slurry to the carbon make-up storage tank (V-17). The carbon is stored as a slurry in this tank and is transferred by gravity to the quench tank as needed.

PERFORMANCE

The efficiency of the wastewater treating plant can be expressed by either or both of two sets of data. Conventionally, the percentage reduction in the concentration of contaminants would be presented. From a practical standpoint, the performance of the plant is best expressed by the quantity of contaminants not adsorbed, i.e., that are discharged, per day. Regardless of the percentage reduction of contaminant concentration achieved, it is of utmost importance that the treating plant be operated in such a manner as to discharge the least quantity (pounds) of contaminants practically possible.

The monitoring schedule for the waste treating plant regularly includes BOD_5, COD, phenol, suspended solids and pH determinations on 24-hour composites of the Parshall flume waste to be treated and of the treated waste to be discharged. In addition, COD concentration is monitored on spot samples of the treated waste at 12-, 8- or 4-hour intervals as needed to assure that discharge limits are not or will not be exceeded.

Our data show that normally the composition of the waste from the equalizing pond to the treating plant changes only at a rate of, e.g., 100 to 200 pounds BOD_5 or COD per day. Process changes in the plant manufacturing area that would markedly affect the waste composition are generally known although accidents can occur. The waste treating plant personnel are thus able to adjust their monitoring frequency and to make appropriate changes in waste feed rate or "slug" frequency as necessary.

The process was designed to operate with a slug frequency of 3 slugs per adsorber per day equivalent to a carbon reactivation rate of 1360 ppm. With the slug frequency set the clarified waste feed rate is set to discharge no more than 75% of the allowable COD discharge limit based on the COD concentration of the spot samples. When and if this control results in an increase in the level of the equalizing basin the slug frequency is increased. This permits processing the waste at a higher rate.

Detailed data indicate that treating efficiency ranges from 60 - 80 percent removal for BOD_5, 65 - 85 percent removal for COD, and 99.3 - 99.9 percent removal for phenol. The high efficiency figures are generally, though not invariably, associated with those periods exhibiting an abnormally high treating load. The carbon "slugging" frequency needed to achieve these higher efficiency levels could not be maintained indefinitely. They are not, however, required in order to meet the average or to stay under the maximum AWIC and EPA limits which form the basis for the RCI discharge permit. These limits and summary results for a six months operating period (see Appendix B) are tabulated below.

	BOD, lbs		COD, lbs		Phenol, lbs		SS, lbs	
Period	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.
EPA	1644	2300	2672	3900	27	27	200	200
Sept '73	1173	1865	2067	2693	3.46	32.0	205.2	592
Oct '73	744	1331	1372	2427	1.86	7.5	87.2	296
Nov '73	1258	2233	2295	3315	0.87	2.2	109.6	221
Dec '73	1167	1700	1917	2602	1.40	6.9	108.0	365
Jan '74	950	1607	1456	2459	3.06	11.2	87.5	213
Feb '74	1035	1454	1577	2572	2.00	5.7	79.7	159

PROBLEMS

In addition to the expected problems associated with equipment start-up and personnel training, a number of situations have developed that were unexpected. Some of these might have been avoided, at least one could not.

Note 1. The equalization basin serves also as an inefficient settler-clarifier. Settled solids will have to be removed (dredging) at approximately yearly intervals to maintain the basic capacity. To the degree that this situation is caused by the location and geometry of the basin the problem is unavoidable.

Note 2. On occasion, anaerobic sulfur-active bacteria have been present in the adsorbers. Source of these bacteria is not known, although corner areas of the equalization basin are virtually stagnant and DO levels in these areas are low to nonexistent. Bacteria growth has been sufficient to coat (and thus to inactivate) carbon particles and to significantly reduce the bed void volume. Carbon capacity has been thus reduced and the hydraulic pressure drop across the bed has been noticeably increased. This situation has from time to time, been temporarily corrected by isolating one adsorber and injecting sufficient caustic soda solution to kill the in situ bacteria. Introduction of sodium nitrate into the adsorber as suggested by the carbon supplier provided little, if any, relief.

Increasing the "slug" frequency serves to reduce the bacteria level to a tolerable value but is expensive in terms of makeup carbon.

A more satisfactory solution to the problem of bacterial growth within the adsorbers must ultimately be found.

Note 3. Wear of the rakes that move carbon particles from one hearth to another in the reactivation furnace appears to be excessive. Useful life of, for example, the teeth has been six months so far. Since furnace temperatures are not excessive, there is no immediate, obvious reason for this short life. The matter is to be investigated by the supplier.

Note 4. For reasons not immediately apparent the life of the bottom, conical, section of the absorbers has been impossibly short. Erosion, not corrosion, seems to be responsible but the localized nature of the failures requires explanation. As this is written the bottom section of one absorber has already been replaced and plans are complete for replacement of the other bottom section.

OPERATING COSTS

Under the present inflationary pressures it is difficult to present any meaningful numerical data for operating costs for the carbon adsorption waste treating plant.

Fixed expenses, including depreciation, insurance, taxes, etc., will certainly vary, depending on plant location, size and waste character. Under local (Tuscaloosa, Alabama) conditions, plant fixed expenses are currently (1974) between $11,000 and $12,000 per month. This equates to about $800 per MM gallons of waste treated.

The material costs are steadily increasing. The major material is, of course, activated carbon. For the six-month period previously mentioned, a carbon balance indicates the following:

Carbon Consumption - 3,445 lbs/MM gallons waste

Carbon Transferred - 69,749 lbs/MM gallons waste

Carbon Lost - 4.94 percent of transfer

The carbon cost, per MM gallons, amounted to almost exactly $1120.00 for the first quarter of 1974. Based on electricity at $0.0138/KWH and natural gas at $0.5872/MCF, the utility cost for the treating plant is between $5,500 and $6,500 per month or about $400.00 per MM gallons.

Personnel requirements for the plant are one operator per eight-hour shift (four men, total) plus an average of one hour per shift of supervision. Direct labor alone amounts to almost $300.00 per MM gallons of waste.

To the foregoing cost figures must be added budgeted amounts for maintenance (approximately $400.00 per MM gallons), general services, administration and overhead. Like fixed expenses, these costs will certainly differ from plant to plant.

SECTION VII

ANALYTICAL METHODS AND GLOSSARY OR TERMS

ANALYTICAL METHODS

Except for DO (dissolved oxygen) which was determined using a Smith and Weston DO Probe all analyses were made employing the appropriate methods outlined in *Standard Methods for the Examination of Water and Wastewater*, thirteenth edition (1).

TERMS

Alkalinity	-	Expressed as equivalent calcium carbonate.
BOD_5	-	Five-day biological oxygen demand.
C(i)	-	Concentration, initial
C(f)	-	Concentration, final
Cl^-	-	Chlorine, expressed as chloride ion.
COD	-	Chemical Oxygen demand.
DO	-	Dissolved oxygen.
DS	-	Dissolved solids.
Equalization Time	-	Tank volume, in gallons/flow, in gallons per day (or hour)
Fe	-	Iron
F/M	-	Oxidation tank loading, pounds BOD_5 per day/pounds MLSS.
GPD	-	Gallons per day.

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(1) Published 1971; American Public Health Association, Inc., 1790 Broadway N.Y., N.Y. 10019

MGD - Million gallons per day.

mg/l - Milligrams/liter.

MLSS - Suspended solids in oxidation tank.

MM - Million.

N - Nitrogen.

P - Phosphorus.

ppm - Parts per million (by weight).

#/D - Pounds per day.

SS - Suspended solids.

SVI - Sludge volume index.

Oxytank - Biological oxidation tank T-7.

TOC - Total organic carbon.

TS - Total solids

VSS % - Percent, by weight, SS volatile at 600° C.

VTS % - Percent, by weight, TS volatile at 600° C.

SECTION VIII

ACKNOWLEDGMENTS

This project was initiated by Mr. T. P. Shumaker, Vice-president, Southern Division, Reichhold Chemical, Inc., in cooperation with the Alabama Geological Survey, Mr. P. E. LaMoreaux, State Geologist and Oil and Gas Supervisor.

The support of the research and development work associated with the project by the Environmental Protection Agency is acknowledged. The assistance and encouragement provided by Mr. E. P. Lomasney as Project officer for the EPA has been extremely helpful and is gratefully acknowledged.

The carbon adsorption process was developed under contract by Calgon, Incorporated, and the actual treating plant was designed by and built under the supervision of that company.

Mr. C. Schimmel, Vice-president, Manufacturing, Southern Division, RCI, acted as project director for RCI with the assistance of Messrs. A. W. West and W. R. Goode.

APPENDIX A

RAW DATA - BIO PLANT

Tables A1 - A8: Oxidation Tank Feed

Tables B1 - B8: Plant Final Effluent

Tables C1 - C8: Oxidation Tank Mixed Liquor

Tables D1 - D8: Oxidation Tank Performance and Waste Sludge

Tables E1 - E8: Equalized Raw Feed, Part I

Tables F1 - F8: Equalized Raw Feed, Part II

Tables G1 - G3: Oxidation Tower Data

TABLE A-1 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
7/30/70	4.1	88	8.2	350	12	0	--	--	--	860	--	2-1	0.82
7/31/70	6.6	85	7.5	359	184	5	--	--	--	720	--	2-1	0.82
8/1/70	7.1	88	8.1	480	4	0	--	--	--	743	--	2-1	0.82
8/2/70	6.3	90	7.9	283	64	32	--	--	--	--	--	2-1	0.82
8/3/70	7.1	86	7.8	234	8	0	--	--	--	--	--	2-1	0.82
8/4/70	5.8	86	7.65	267	36	34	--	--	--	610	--	2-1	0.82
8/5/70	5.0	84	7.6	276	24	0	--	--	--	609	--	2-1	0.82
8/6/70	4.4	84	7.2	182	36	22	--	--	--	590	--	2-1	0.82
8/7/70	5.1	84	7.2	148	8	100	--	--	--	395	--	2-1	1.09
8/8/70	6.2	81	7.7	186	--	--	--	--	--	--	--	2-1	0.82
8/9/70	6.5	84	7.3	--	--	--	--	--	--	--	--	2-1	0.82
8/10/70	--	80	8.0	141	4	100	--	--	--	375	--	Batch	Batch
8/11/70	--	--	--	--	--	--	--	--	--	528	10.44	Batch	Batch
8/12/70	--	--	--	--	--	--	--	--	--	--	--	Batch	Batch
8/13/70	--	--	--	--	--	--	--	--	--	--	4.0	2-1	0.82
8/14/70	--	--	--	--	--	--	--	--	--	--	--	2-1	0.82
8/15/70	--	--	9.8	--	--	--	--	--	--	--	--	Batch	Batch
8/16/70	--	--	7.4	--	--	--	--	--	--	--	--	Batch	Batch
8/17/70	5.1	82	7.7	--	--	--	--	--	--	--	--	Batch	Batch
8/18/70	4.2	89	7.7	--	--	--	--	--	--	606	--	2-1	0.82
8/19/70	3.3	80	7.7	--	44	73	--	--	--	620	44	2-1	1.09
8/20/70	--	--	--	--	36	0	--	--	--	300	--	2-1	1.09
8/21/70	1.1	82	7.5	--	--	--	--	--	--	--	--	2-1	1.64
8/22/70	5.4	78	7.8	150	--	--	--	--	--	--	--	2-1	1.64
8/23/70	--	--	--	--	--	--	--	--	--	--	--	2-1	1.64
8/24/70	--	--	--	--	--	--	--	--	--	--	--	2-1	1.64
8/25/70	--	--	--	--	--	--	--	--	--	--	--	2-1	1.64
8/26/70	--	--	--	--	--	--	--	--	--	--	--	2-1	1.64
8/27/70	4.3	82	9.3	--	30	67	--	--	--	--	--	2-1	3.26
8/28/70	4.7	80	9.7	496	50	50	--	--	--	1255	--	2-1	3.26
8/29/70	4.5	82	9.4	766	75	53	--	--	--	--	--	2-1	1.63
8/30/70	3.5	86	9.0	698	45	88	--	--	--	1590	--	2-1	1.63
8/31/70	4.3	84	8.7	498	95	84	--	--	--	--	--	2-1	3.26

TABLE A-2 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
9/1/70	3.5	86	8.8	622	120	100	--	--	--	1710	88.2	2-1	3.26
9/2/70	1.8	85	8.6	742	12	100	--	--	--	--	--	2-1	3.26
9/3/70	1.7	83	8.2	421	80	100	--	--	--	1670	43.8	2-1	3.26
9/4/70	3.1	81	7.8	735	5	100	--	--	--	1880	--	2-1	3.26
9/5/70	4.0	82	8.3	525	0	--	--	--	--	1630	--	2-1	3.26
9/6/70	3.4	82	7.7	606	50	33	--	--	--	1980	--	2-1	3.26
9/7/70	1.5	84	4.6	831	5	0	--	--	--	2120	--	2-1	3.26
9/8/70	1.0	81	8.6	517	88	40	--	--	--	1500	--	2-1	3.26
9/9/70	3.0	84	8.5	523	50	40	--	--	--	1605	--	2-1	3.26
9/10/70	1.2	83	8.3	--	--	--	--	--	--	--	--	2-1	3.26
9/11/70	0.46	78	8.0	832	85	71	--	--	--	2560	--	1-1	3.26
9/12/70	0.00	77	7.0	810	--	--	--	--	--	1960	--	1-1	3.26
9/13/70	0.9	77	8.7	810	4	100	--	--	--	--	--	1-1	3.26
9/14/70	1.0	78	8.8	--	60	100	--	--	--	1580	--	1-1	3.26
9/15/70	1.0	78	9.3	--	108	67	--	--	--	2097	37.5	1-1	3.26
9/16/70	2.7	80	8.9	--	112	84	--	--	--	1678	--	1-1	3.26
9/17/70	1.7	78	8.6	--	72	89	--	--	--	1640	--	1-1	3.26
9/18/70	2.6	78	9.1	--	--	--	--	--	--	--	--	2-1	1.53
9/19/70	1.4	84	10.0	--	--	--	--	--	--	--	--	2-1	1.53
9/20/70	2.3	85	10.2	--	--	--	--	--	--	--	--	2-1	1.53
9/21/70	2.6	87	9.4	--	--	--	--	--	--	--	--	2-1	1.53
9/22/70	4.3	80	8.1	--	--	--	--	--	--	--	--	2-1	1.53
9/23/70	6.2	84	10.5	--	--	--	--	--	--	--	--	2-1	1.53
9/24/70	2.1	82	9.6	823	76	90	--	--	--	2500	--	2-1	1.53
9/25/70	6.2	79	10.8	975	135	26	--	--	--	2360	--	2-1	1.53
9/26/70	7.0	80	11.1	1021	10	100	--	--	--	2690	--	2-1	1.53
9/27/70	7.1	78	11.2	719	--	--	--	--	--	2040	--	2-1	1.53
9/28/70	7.5	77	10.6	860	4	0	--	--	--	2110	--	2-1	1.53
9/29/70	7.6	72	11.1	607	--	--	--	--	--	1940	--	2-1	2.00
9/30/70	7.0	75	10.8	1426	430	16	--	--	--	2360	--	2-1	3.26

TABLE A-3 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
10/1/70	8.0	73	10.5	1107	0	100	--	--	--	2440	--	2-1	3.26
10/2/70	7.5	74	10.4	861	55	27	--	--	--	1780	--	2-1	3.26
10/3/70	--	--	--	782	95	84	--	--	--	--	--	2-1	3.26
10/4/70	7.0	79	10.8	--	--	--	--	--	--	3909	--	2-1	3.26
10/5/70	7.8	78	10.2	--	35	100	--	--	--	--	--	2-1	3.26
10/6/70	8.8	74	10.3	--	60	55	--	--	--	3290	--	2-1	3.26
10/7/70	7.5	77	10.0	1750	20	50	4462	20	4442	3909	--	2-1	3.26
10/8/70	7.4	74	10.1	2040	60	0	5444	41	5384	--	--	2-1	3.26
10/9/70	6.1	75	9.7	1080	60	57	3142	21	3082	2740	--	2-1	3.26
10/10/70	7.6	70	8.6	888	20	75	2668	25	2648	2200	--	2-1	3.26
10/11/70	7.6	75	8.9	--	--	--	--	--	--	--	--	2-1	3.26
10/12/70	7.3	75	9.5	878	60	75	2284	24	2214	2060	--	2-1	3.26
10/13/70	7.8	74	9.4	596	30	50	2054	22	2024	1882	--	2-1	3.26
10/14/70	7.7	76	9.9	840	15	15	--	--	--	1600	101.0	2-1	3.26
10/15/70	7.6	72	10.2	495	35	14	--	--	--	1460	--	2-1	3.26
10/16/70	8.6	68	10.8	--	--	--	--	--	--	--	--	2-1	3.26
10/17/70	--	--	--	--	--	--	--	--	--	1248	--	2-1	3.26
10/18/70	--	--	--	--	--	--	--	--	--	--	--	2-1	3.26
10/19/70	7.1	67	11.0	880	175	57	--	--	--	--	--	2-1	3.26
10/20/70	9.2	66	11.2	--	10	--	--	--	--	--	--	2-1	3.26
10/21/70	7.8	69	10.2	--	--	--	--	--	--	658	--	2-1	3.26
10/22/70	7.7	66	11.2	--	80	100	--	--	--	1238	--	2-1	3.26
10/23/70	8.1	68	8.9	--	70	72	2520	21	2450	2500	--	2-1	3.26
10/24/70	8.0	70	10.4	--	85	88	--	--	--	1668	--	2-1	3.26
10/25/70	7.4	69	9.2	810	--	--	1804	19	--	1820	--	2-1	3.26
10/26/70	8.8	72	7.6	1200	20	75	2248	32	2228	1998	--	2-1	3.26
10/27/70	11.6	69	7.7	1620	80	100	--	--	--	1795	--	2-1	3.26
10/28/70	11.2	61	6.6	1020	100	60	2554	33	2454	2340	--	2-1	3.26
10/29/70	--	--	--	--	--	--	--	--	--	--	--	2-1	3.26
10/30/70	--	66	7.8	720	--	--	--	--	--	--	--	2-1	3.26
10/31/70	6.4	64	8.8	--	--	--	--	--	--	--	--	2-1	3.26

TABLE A-4 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
11/1/70	7.4	69	8.2	1620	105	0	--	--	--	--	--	2-1	3.26
11/2/70	9.0	66	8.4	816	84	76	1470	40	1386	1260	--	2-1	3.26
11/3/70	10.0	59	8.4	388	--	--	1726	41	--	1500	--	2-1	3.26
11/4/70	10.1	60	10.0	427	35	86	1614	44	1579	1545	--	2-1	3.26
11/5/70	9.8	59	7.3	--	45	--	2002	--	1957	1788	--	2-1	3.26
11/6/70	--	--	--	--	--	--	--	--	--	--	--	NONE	3.26
11/7/70	9.0	75	10.4	570	--	--	--	--	--	1390	--	--	3.26
11/8/70	6.4	77	9.7	385	--	--	--	--	--	960	--	--	3.26
11/9/70	8.8	79	10.8	720	105	47	1630	30	1525	1538	--	--	3.26
11/10/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/11/70	9.8	75	7.8	--	100	60	3664	27	3564	2860	--	--	3.26
11/12/70	8.4	73	11.8	883	50	50	3396	33	3346	2120	--	--	3.26
11/13/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/14/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/15/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/16/70	--	--	--	455	15	100	--	--	--	1482	--	--	3.26
11/17/70	10.2	63	10.7	488	165	100	--	--	--	1500	23.5	--	3.26
11/18/70	8.4	63	7.2	945	35	100	--	--	--	2260	--	--	3.26
11/19/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/20/70	7.8	62	7.4	3000	80	63	--	--	--	6130	230.0	--	3.26
11/21/70	7.5	69	9.5	1170	90	67	--	--	--	3850	--	--	3.26
11/22/70	6.0	71	7.8	--	--	--	--	--	--	--	--	--	3.26
11/23/70	4.4	68	7.9	2220	45	100	--	--	--	4180	--	--	3.26
11/24/70	5.6	52	8.7	910	--	--	--	--	--	--	73.0	--	3.26
11/25/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/26/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/27/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/28/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/29/70	--	--	--	--	--	--	--	--	--	--	--	--	3.26
11/30/70	1.4	80	8.2	1065	130	85	--	--	--	2500	--	--	3.26

TABLE A-5 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
12/1/70	2.9	72	8.2	1225	80	56	--	--	--	3260	268.8	--	3.26
12/2/70	5.0	74	9.7	947	55	100	--	--	--	2180	--	--	3.26
12/3/70	3.0	80	8.6	1070	195	72	--	--	--	3070	258.0	--	3.26
12/4/70	8.4	79	7.3	1610	--	--	--	--	--	3210	--	--	3.26
12/5/70	2.3	73	9.5	230	300	67	--	--	--	3660	--	--	3.26
12/6/70	4.0	72	8.5	1218	135	74	--	--	--	2490	--	--	3.26
12/7/70	3.1	66	8.2	1325	165	30	--	--	--	2990	--	--	3.26
12/8/70	2.9	65	10.1	1342	80	100	--	--	--	2850	108.7	--	3.26
12/9/70	7.4	76	11.2	690	--	--	--	--	--	3500	--	--	2.80
12/10/70	8.2	76	11.4	1230	85	100	--	--	--	3110	--	--	2.80
12/11/70	8.1	78	10.6	1485	70	86	--	--	--	3090	--	--	2.80
12/12/70	8.4	78	10.2	1455	135	52	--	--	--	3100	--	--	2.80
12/13/70	8.0	67	10.9	887	0	--	--	--	--	3550	--	None	2.8
12/14/70	9.2	67	10.9	1398	100	90	--	--	--	2240	--	None	2.8
12/15/70	9.1	68	11.2	1304	130	46	--	--	--	2800	--	None	2.8
12/16/70	9.0	68	11.2	1745	130	69	--	--	--	3220	--	None	2.8
12/17/70	6.4	72	11.0	1530	70	50	--	--	--	2200	--	None	2.8
12/18/70	8.3	73	11.3	945	50	100	--	--	--	4950	--	None	2.8
12/19/70	7.8	70	10.9	4380	--	--	--	--	--	8150	--	None	2.8
12/20/70	7.2	70	11.0	3000	--	--	--	--	--	3600	--	None	Batch
12/21/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/22/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/23/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/24/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/25/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/26/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/27/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/28/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/29/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/30/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch
12/31/70	--	--	--	--	--	--	--	--	--	--	--	None	Batch

TABLE A-6 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
1/1/71	--	--	--	--	--	--	--	--	--	--	--	None	Batch
1/2/71	--	--	--	--	--	--	--	--	--	--	--	None	Batch
1/3/71	--	--	--	--	--	--	--	--	--	--	--	None	Batch
1/4/71	--	--	--	--	--	--	--	--	--	--	--	None	Batch
1/5/71	--	--	--	--	--	--	--	--	--	--	--	None	1.08
1/6/71	--	--	--	--	--	--	--	--	--	--	--	None	1.08
1/7/71	8.3	63	11.2	950	75	53	--	--	--	1903	--	None	1.08
1/8/71	8.7	57	10.8	405	--	--	--	--	--	1260	--	None	1.08
1/9/71	--	--	--	--	--	--	--	--	--	--	--	None	1.08
1/10/71	5.5	62	11.0	1290	120	100	--	--	--	2800	--	None	1.08
1/11/71	4.8	65	10.9	1220	130	100	--	--	--	2520	--	None	1.08
1/12/71	1.0	64	4.5	--	165	76	--	--	--	--	--	None	0.48
1/13/71	8.2	63	6.4	4740	185	68	--	--	--	6950	--	None	0.48
1/14/71	8.5	72	6.5	3570	120	27	--	--	--	7700	--	None	0.48
1/15/71	8.2	72	10.0	2000	200	25	--	--	--	5569	--	None	0.48
1/16/71	7.0	72	10.2	1110	130	65	--	--	--	3248	--	None	0.48
1/17/71	6.0	61	4.9	1800	135	44	--	--	--	5999	--	None	0.48
1/18/71	6.6	62	10.0	2520	80	69	--	--	--	5097	--	None	0.48
1/19/71	9.4	54	11.8	1815	245	30	--	--	--	5452	--	None	0.48
1/20/71	7.4	58	11.1	1305	100	40	--	--	--	3049	--	None	0.65
1/21/71	8.4	50	11.1	1620	70	100	--	--	--	3206	--	None	0.65
1/22/71	3.2	70	9.5	5082	140	82	--	--	--	15360	--	None	0.65
1/23/71	3.5	66	9.7	2910	75	60	--	--	--	7101	--	None	0.65
1/24/71	2.4	76	8.3	3795	85	19	--	--	--	5350	--	None	0.65
1/25/71	8.8	68	11.3	1740	105	19	--	--	--	4930	37.5	None	0.48
1/26/71	7.3	66	11.7	2835	60	0	--	--	--	7370	--	None	0.48
1/27/71	7.3	56	9.1	2535	105	62	--	--	--	9979	--	None	0.48
1/28/71	10.9	50	8.8	4800	165	45	--	--	--	10943	--	None	0.48
1/29/71	--	--	--	--	--	--	--	--	--	--	--	--	0.48
1/30/71	7.2	70	9.0	822	185	81	--	--	--	3650	--	--	0.48
1/31/71	10.2	59	9.2	945	5	100	--	--	--	3250	--	--	0.54

TABLE A-7 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
2/1/71	7.9	55	11.5	780	15	100	--	--	--	2427	--	--	0.54
2/2/71	10.5	47	11.8	380	25	60	--	--	--	1778	--	--	0.54
2/3/71	1.9	58	7.4	3780	110	68	--	--	--	8674	--	--	0.54
2/4/71	9.1	65	11.1	636	50	100	--	--	--	2133	--	--	0.54
2/5/71	5.0	62	10.5	1335	195	0	--	--	--	3508	--	--	0.54
2/6/71	9.2	66	12.0	2330	160	100	--	--	--	5450	--	--	0.54
2/7/71	9.2	56	12.1	--	205	--	--	--	--	[illegible]9	--	--	0.54
2/8/71	9.6	47	9.4	1282	50	100	--	--	--	3120	--	--	0.54
2/9/71	9.0	42	9.4	1055	95	100	--	--	--	3189	--	--	0.54
2/10/71	10.8	48	12.5	916	215	58	--	--	--	3835	--	--	0.54
2/11/71	8.8	58	12.2	1890	70	71	--	--	--	4454	--	--	0.815
2/12/71	10.0	57	12.4	748	120	71	--	--	--	2672	--	--	0.815
2/13/71	10.4	50	11.7	3000	--	--	--	--	--	13964	--	--	0.815
2/14/71	10.7	52	11.8	1072	190	79	--	--	--	3030	--	--	0.815
2/15/71	9.9	55	12.5	1302	315	44	--	--	--	3166	--	--	0.815
2/16/71	8.3	64	11.4	1980	240	44	--	--	--	3638	--	--	0.815
2/17/71	7.3	66	12.0	1830	110	32	--	--	--	3556	--	--	0.815
2/18/71	7.4	66	11.9	1614	85	59	--	--	--	3470	--	--	0.815
2/19/71	9.1	64	11.8	1800	50	60	--	--	--	3720	--	--	0.815
2/20/71	8.6	66	11.9	1515	75	60	--	--	--	3612	--	--	0.815
2/21/71	8.1	67	11.8	760	165	33	--	--	--	1552	--	--	0.815
2/22/71	8.9	67	11.4	663	105	100	--	--	--	1322	--	--	0.815
2/23/71	9.8	59	11.4	587	145	100	--	--	--	1303	--	--	0.815
2/24/71	10.1	56	11.1	605	35	86	--	--	--	1194	--	--	0.815
2/25/71	8.0	64	11.2	3270	115	91	5050	17	4935	7862	--	--	1.63
2/26/71	7.5	68	11.7	2110	75	47	--	--	--	4032	--	--	1.63
2/27/71	8.4	66	11.2	1475	70	63	--	--	--	4203	--	--	1.63
2/28/71	8.1	67	10.6	1225	80	13	--	--	--	3107	--	--	1.63

TABLE A-8 RAW DATA - FEED TO OXIDATION TANK

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM	Dilution Factor	Flow GPM
3/1/71	7.8	71	10.0	1575	80	87	2186	45	2106	4541	--	--	1.63
3/2/71	7.6	72	10.3	1560	80	87	3420	31	3340	3528	--	--	1.63
3/3/71	9.0	62	11.1	1223	90	83	3818	20	3728	3146	--	--	1.63
3/4/71	10.9	49	11.0	1320	100	15	3804	25	3704	3283	--	--	1.63
3/5/71	9.2	56	9.7	1130	65	85	3018	29	2953	2225	--	--	1.63
3/6/71	8.3	66	9.2	2437	275	96	4562	17	4287	5232	--	--	1.63
3/7/71	8.4	58	9.9	2175	100	90	4168	22	4068	4598	--	--	1.63
3/8/71	8.3	57	9.8	2325	95	90	--	--	--	6844	--	--	1.63
3/9/71	8.7	57	10.6	1942	145	79	--	--	--	4560	--	--	1.63
3/10/71	8.4	61	11.3	2340	135	74	--	--	--	4254	--	--	1.63
3/11/71	8.5	63	10.1	2580	75	67	--	--	--	5188	--	--	1.63
3/12/71	8.6	62	11.2	2460	70	86	--	--	--	4958	--	--	1.63
3/13/71	8.3	67	10.4	3525	95	53	--	--	--	6763	--	--	1.63
3/14/71	8.2	72	10.2	1475	--	--	--	--	--	3790	--	--	1.63
3/15/71	7.1	70	8.9	3675	75	67	--	--	--	5589	--	None	1.63
3/16/71	8.8	67	9.3	2490	100	75	--	--	--	4944	--	None	1.63
3/17/71	9.3	62	9.8	1980	155	74	--	--	--	4570	--	None	1.63
3/18/71	9.2	76	11.3	856	55	82	--	--	--	2543	--	None	1.63
3/19/71	10.0	61	11.2	796	140	61	--	--	--	2180	--	None	1.63
3/20/71	9.9	67	7.8	802	95	88	--	--	--	2475	--	None	1.63
3/21/71	9.0	78	7.5	1625	90	83	--	--	--	2925	--	None	1.63
3/22/71	9.2	66	12.0	967	50	70	--	--	--	2012	--	None	1.63
3/23/71	9.3	65	11.7	1470	105	67	--	--	--	3938	--	None	1.63
3/24/71	10.2	60	11.8	1635	95	68	--	--	--	4061	--	None	1.63
3/25/71	10.4	58	11.2	975	75	66	--	--	--	2920	--	None	1.63
3/26/71	10.3	64	10.6	--	--	--	--	--	--	2777	--	None	1.63
3/27/71	10.2	64	11.0	--	145	69	--	--	--	3607	--	None	1.63
3/28/71	9.2	66	10.2	--	--	--	--	--	--	3779	--	None	1.63
3/29/71	8.8	71	10.2	--	160	59	--	--	--	3389	--	None	1.63
3/30/71	8.9	66	9.9	--	90	55	--	--	--	2561	--	None	1.63
3/31/71	6.2	68	9.6	--	80	56	--	--	--	2651	--	None	1.63

TABLE B-1 RAW DATA - PLANT FINAL EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
7/30/70	4.1	88	7.2	30	28	57	502	--	474	254	--
7/31/70	6.4	83	7.2	26	208	57	614	--	406	140	--
8/1/70	4.9	88	7.4	55	--	--	496	--	--	133	--
8/2/70	5.0	90	7.0	19	104	17	824	--	720	--	--
8/3/70	5.5	88	7.0	20	8	100	708	--	700	113	--
8/4/70	5.9	88	7.1	7	52	31	760	--	708	76	--
8/5/70	3.9	86	6.9	10	8	0	780	--	772	95	--
8/6/70	4.3	84	7.2	20	4	0	882	--	818	192	0.5
8/7/70	6.1	85	7.6	15	12	67	798	--	786	95	--
8/8/70	6.8	83	7.7	10	--	--	--	--	--	--	--
8/9/70	7.1	84	7.6	--	--	--	--	--	--	--	--
8/10/70	--	--	--	40	8	100	--	--	--	106	--
8/11/70	--	--	--	--	--	--	--	--	--	178	1.36
8/12/70	--	--	--	--	--	--	--	--	--	--	--
8/13/70	--	--	--	--	--	--	--	--	--	--	1.8
8/14/70	--	--	--	--	--	--	--	--	--	57	--
8/15/70	--	--	--	--	--	--	--	--	--	98	--
8/16/70	--	--	--	--	--	--	--	--	--	--	--
8/17/70	--	--	--	--	--	--	--	--	--	97	--
8/18/70	5.0	80	7.1	--	--	--	680	24	--	81	1.14
8/19/70	--	--	--	--	32	0	680	--	684	94	--
8/20/70	5.2	78	6.9	--	48	33	582	--	534	--	0.44
8/21/70	5.1	82	7.3	--	--	--	--	--	--	--	--
8/22/70	5.0	79	7.3	10	--	--	--	--	--	--	--
8/23/70	--	--	--	--	--	--	--	--	--	--	--
8/24/70	--	--	--	--	--	--	--	--	--	--	--
8/25/70	--	--	--	--	--	--	--	--	--	--	--
8/26/70	--	--	--	--	--	--	--	-	--	--	--
8/27/70	4.5	80	7.6	--	0	--	--	--	--	--	--
8/28/70	3.8	80	7.7	18	10	100	--	--	--	58	--
8/29/70	3.2	84	7.5	240	5	100	--	--	--	--	--
8/30/70	3.6	84	7.5	570	45	100	--	--	--	984	--
8/31/70	2.1	85	7.25	267	70	100	--	--	--	--	--

TABLE B-2 RAW DATA - PLANT FINAL EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
9/1/70	1.3	86	7.3	339	125	80	--	--	--	999	0.85
9/2/70	3.9	85	7.6	435	45	67	--	--	--	--	--
9/3/70	3.7	83	7.6	367	70	71	--	--	--	694	1.0
9/4/70	1.0	81	7.6	401	75	100	2400	19	2325	1260	--
9/5/70	4.4	84	7.7	318	30	100	2180	34	2150	1140	--
9/6/70	4.0	82	7.8	308	16	98	--	--	--	1230	--
9/7/70	4.6	84	8.0	427	75	27	--	--	--	1285	--
9/8/70	4.6	83	8.0	314	280	0	2270	18	1990	1195	0.28
9/9/70	4.0	83	7.9	312	40	0	2128	14	2088	1145	--
9/10/70	4.8	86	8.0	--	--	--	--	--	--	--	--
9/11/70	3.0	82	7.9	337	10	100	5140	18	5130	1315	--
9/12/70	1.6	80	7.7	585	94	--	3108	15	3014	1670	--
9/13/70	2.0	80	7.8	366	32	100	3192	18	3160	--	--
9/14/70	3.8	82	7.9	232	44	82	3094	47	3050	1150	--
9/15/70	4.4	79	8.0	253	40	70	2582	--	2542	1110	0.0
9/16/70	4.1	82	7.9	177	47	78	2400	--	2353	1119	--
9/17/70	4.2	80	8.0	195	72	94	2480	--	--	1140	--
9/18/70	4.7	80	8.0	--	--	--	--	--	--	--	--
9/19/70	3.4	86	7.9	--	--	--	--	--	--	--	--
9/20/70	2.3	85	7.8	--	--	--	--	--	--	--	--
9/21/70	3.6	86	8.0	--	--	--	--	--	--	--	--
9/22/70	2.9	82	7.9	--	--	--	--	--	--	--	--
9/23/70	3.4	83	7.8	--	--	--	--	--	--	--	--
9/24/70	4.7	79	7.8	124	60	87	1996	17	1936	695	--
9/25/70	--	--	--	122	205	44	2046	16	2002	561	0.0
9/26/70	4.8	82	7.8	131	20	75	2188	18	2168	602	--
9/27/70	4.8	78	7.9	110	--	--	--	--	--	430	--
9/28/70	5.1	76	8.1	180	40	0	2318	15	2278	716	--
9/29/70	--	--	--	100	--	--	--	--	--	832	0.2
9/30/70	5.5	74	8.1	198	100	5	2380	15	2280	765	--

TABLE B-3 RAW DATA - PLANT EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
10/1/70	5.0	73	8.0	244	145	90	2726	13	2581	806	1.85
10/2/70	5.4	75	8.0	174	95	16	2772	18	2677	923	--
10/3/70	5.8	76	7.9	288	105	57	2622	16	2517	816	--
10/4/70	6.7	78	7.9	--	--	--	--	--	--	--	--
10/5/70	5.6	75	8.1	--	20	100	2522	15	2502	--	--
10/6/70	5.1	73	8.1	--	--	--	--	--	--	--	--
10/7/70	6.8	75	7.8	847	75	62	--	--	--	2145	--
10/8/70	2.0	70	7.5	474	140	54	3900	21	2760	--	--
10/9/70	2.4	75	7.7	1010	110	91	3794	18	3684	2680	--
10/10/70	2.0	70	7.5	680	120	100	3130	19	3010	1640	--
10/11/70	5.6	77	7.8	--	--	--	--	--	--	--	--
10/12/70	5.8	76	7.7	337	75	74	2252	21	2177	1445	--
10/13/70	5.8	75	7.6	298	130	42	--	--	--	1300	0.34
10/14/70	6.0	75	7.5	230	90	90	--	--	--	--	0.30
10/15/70	6.3	72	7.8	335	20	0	--	--	--	874	--
10/16/70	6.2	67	7.8	--	--	--	--	--	--	--	--
10/17/70	--	--	--	--	--	--	--	--	--	643	--
10/18/70	--	--	--	--	--	--	--	--	--	--	--
10/19/70	6.4	66	8.1	221	65	69	--	--	--	--	--
10/20/70	8.0	65	8.2	--	70	21	--	--	--	--	--
10/21/70	6.4	68	8.1	--	--	--	--	--	--	580	--
10/22/70	6.2	65	8.0	--	85	100	--	--	--	690	--
10/23/70	5.7	68	7.8	--	95	53	1496	18	1401	816	--
10/24/70	6.5	69	7.9	--	35	28	--	--	--	1127	--
10/25/70	7.6	69	7.8	205	--	--	1852	15	--	1000	--
10/26/70	7.8	72	7.8	367	25	40	1852	33	1827	1095	--
10/27/70	7.2	68	7.5	540	10	0	--	--	--	960	--
10/28/70	7.8	68	7.4	285	110	64	1742	33	1632	978	--
10/29/70	--	--	--	--	--	--	--	--	--	--	--
10/30/70	--	--	--	180	--	--	--	--	--	--	--
10/31/70	3.4	63	7.7	--	--	--	--	--	--	--	--

TABLE B-4 RAW DATA - PLANT FINAL EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
11/1/70	4.7	68	7.3	870	105	0	--	--	--	--	--
11/2/70	5.6	66	7.9	458	240	79	3234	21	2994	--	--
11/3/70	6.2	57	7.8	180	45	100	2420	39	2375	1350	--
11/4/70	7.1	59	6.1	126	60	67	1984	33	1824	989	2.5
11/5/70	7.2	56	7.7	--	35	--	1902	--	1867	970	--
11/6/70	--	--	--	--	--	--	--	--	--	--	--
11/7/70	5.5	66	7.7	705	--	--	--	--	--	2140	--
11/8/70	6.4	69	7.9	330	--	--	--	--	--	1055	--
11/9/70	7.1	72	7.8	420	175	66	2126	25	1951	860	--
11/10/70	--	--	--	--	--	--	--	--	--	--	--
11/11/70	6.3	64	7.8	--	75	20	2112	28	2037	680	--
11/12/70	5.4	64	7.3	187	140	100	2446	25	2306	887	--
11/13/70	--	--	--	--	--	--	--	--	--	--	--
11/14/70	--	--	--	--	--	--	--	--	--	--	--
11/15/70	--	--	--	--	--	--	--	--	--	--	--
11/16/70	--	--	--	64	56	100	1446	34	1390	430	--
11/17/70	6.7	91	8.0	42	260	100	1896	26	1636	630	0.13
11/18/70	6.0	74	8.1	84	85	100	1966	31	1881	650	--
11/19/70	--	--	--	--	--	--	--	--	--	774	--
11/20/70	3.8	66	7.7	150	140	57	2472	24	2332	772	0.13
11/21/70	5.5	83	7.8	360	--	--	--	--	--	1740	--
11/22/70	5.1	78	7.7	90	--	--	--	--	--	--	--
11/23/70	4.2	67	7.6	525	50	100	3414	14	3664	1750	--
11/24/70	5.4	62	7.7	430	--	--	--	--	--	--	0.2
11/25/70	--	--	--	--	--	--	--	--	--	--	--
11/26/70	--	--	--	--	--	--	--	--	--	--	--
11/27/70	--	--	--	--	--	--	--	--	--	--	--
11/28/70	--	--	--	--	--	--	--	--	--	--	--
11/29/70	--	--	--	--	--	--	--	--	--	--	--
11/30/70	2.1	84	7.8	264	20	75	2082	34	2062	670	--

TABLE B-5 RAW DATA - PLANT FINAL EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
12/1/70	4.2	82	7.9	263	100	35	2456	32	2356	1260	31.0
12/2/70	4.9	81	7.9	350	60	0	2500	23	2440	1210	--
12/3/70	--	--	--	201	70	100	2234	24	2264	895	0.92
12/4/70	6.4	82	7.6	297	70	100	2386	24	2316	1270	--
12/5/70	7.5	72	8.4	486	90	67	2388	15	2298	597	--
12/6/70	9.6	67	8.0	310	80	100	2290	18	2210	1005	--
12/7/70	5.5	74	8.0	460	265	41	2780	20	2515	1365	--
12/8/70	5.6	80	8.1	535	10	0	3002	26	2992	1500	0.5
12/9/70	5.6	80	8.1	310	215	70	3234	26	3019	1330	--
12/10/70	6.4	81	8.2	288	240	100	3476	25	3236	1420	--
12/11/70	6.5	83	8.0	648	65	100	3656	28	3591	1595	--
12/12/70	7.1	78	8.0	422	130	100	3652	20	3522	1550	--
12/13/70	6.8	78	7.7	330	45	100	--	--	--	1390	--
12/14/70	6.8	74	8.0	358	75	40	3152	20	3077	1300	--
12/15/70	6.6	73	8.1	415	115	92	3380	25	3265	1278	--
12/16/70	6.9	77	7.8	408	125	48	3074	21	2949	975	--
12/17/70	6.8	74	8.3	315	35	100	2990	28	2955	1000	--
12/18/70	7.5	75	8.0	280	115	100	3364	10	3249	1000	--
12/19/70	6.8	72	8.2	385	50	100	--	--	--	625	--
12/20/70	2.5	73	8.0	589	70	100	--	--	--	1850	--
12/21/70	--	--	--	--	--	--	--	--	--	--	--
12/22/70	--	--	--	--	--	--	--	-	--	--	--
12/23/70	--	--	--	--	--	--	--	--	--	--	--
12/24/70	--	--	--	--	--	--	--	--	--	--	--
12/25/70	--	--	--	--	--	--	--	--	--	--	--
12/26/70	--	--	--	--	--	--	--	--	--	--	--
12/27/70	--	--	--	--	--	--	--	--	--	--	--
12/28/70	--	--	--	--	--	--	--	--	--	--	--
12/29/70	--	--	--	--	--	--	--	--	--	--	--
12/30/70	--	--	--	--	--	--	--	--	--	--	--
12/31/70	--	--	--	--	--	--	--	--	--	--	--

TABLE B-6 RAW DATA - PLANT FINAL EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
1/1/71	--	--	--	--	--	--	--	--	--	--	--
1/2/71	--	--	--	--	--	--	--	--	--	--	--
1/3/71	--	--	--	--	--	--	--	--	--	--	--
1/4/71	--	--	--	--	--	--	--	--	--	--	--
1/5/71	--	--	--	--	--	--	--	--	--	--	--
1/6/71	--	--	--	--	--	--	--	--	--	--	--
1/7/71	--	--	--	180	--	--	--	--	--	631	--
1/8/71	--	--	--	20	--	--	--	--	--	547	--
1/9/71	4.9	85	7.9	--	--	--	--	--	--	--	--
1/10/71	4.5	60	8.0	36	30	100	--	--	--	760	--
1/11/71	6.0	68	8.0	0	165	92	--	--	--	292	--
1/12/71	1.2	69	7.6	--	65	100	--	--	--	--	--
1/13/71	3.8	70	7.7	1130	15	100	--	--	--	2150	--
1/14/71	4.0	70	7.6	780	55	91	6872	17	6817	2410	--
1/15/71	3.3	70	7.5	606	150	100	--	--	--	2284	--
1/16/71	5.0	72	7.9	540	75	80	9334	54	9259	2041	--
1/17/71	5.0	74	7.9	567	35	43	6204	10	6169	1923	--
1/18/71	5.2	66	8.0	573	90	68	6184	10	6094	1888	--
1/19/71	6.7	59	8.1	500	175	63	6230	8	6055	1887	--
1/20/71	5.2	60	8.1	471	30	100	6162	22	6132	1709	--
1/21/71	5.4	58	8.4	503	35	85	6608	20	6573	1727	--
1/22/71	1.0	74	8.3	899	150	16	--	--	--	1690	--
1/23/71	6.1	74	8.2	685	150	50	--	--	--	2255	--
1/24/71	7.4	68	11.7	1083	100	85	7964	8	7864	2125	--
1/25/71	5.8	82	7.9	790	75	40	--	--	--	1992	0.12
1/26/71	5.6	76	8.1	656	190	68	--	--	--	1045	--
1/27/71	7.2	65	8.1	466	60	100	--	--	--	1884	--
1/28/71	8.2	64	8.6	735	140	54	8142	10	8002	2183	--
1/29/71	--	--	--	--	--	--	--	--	--	--	--
1/30/71	3.2	72	8.0	620	105	100	--	--	--	1900	--
1/31/71	4.0	67	7.9	403	5	100	3434	19	3429	1500	--

TABLE B-7 RAW DATA - PLANT FINAL EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
2/1/71	5.3	58	7.9	103	130	15	6778	14	6448	947	--
2/2/71	7.8	67	8.2	60	7	86	5922	15	5852	959	--
2/3/71	6.4	69	7.7	65	125	24	5570	13	5445	735	--
2/4/71	5.8	73	7.8	60	135	93	5266	13	5131	877	--
2/5/71	6.0	64	7.9	48	135	44	4984	15	4849	593	--
2/6/71	5.8	74	8.6	102	60	100	5006	12	4946	924	--
2/7/71	4.0	72	8.4	149	--	--	5152	14	--	1104	--
2/8/71	6.1	53	8.4	173	105	48	5126	13	5021	1104	--
2/9/71	--	--	--	67	--	--	5252	20	--	975	--
2/10/71	6.5	57	8.4	113	250	76	5126	17	4876	809	--
2/11/71	5.6	72	8.3	20	75	60	4868	11	4793	661	
2/12/71	7.7	75	8.6	20	210	95	4588	18	4378	865	--
2/13/71	7.1	65	8.2	62	--	--	5990	32	--	1169	--
2/14/71	7.7	74	8.2	15	325	85	4996	20	4671	1115	--
2/15/71	5.8	67	8.6	19	290	98	5470	18	5180	1020	--
2/16/71	2.0	76	8.4	30	--	--	4896	18	--	970	0.1
2/17/71	4.1	78	8.5	20	140	50	5084	14	4944	815	--
2/18/71	4.8	74	8.5	10	70	86	4688	13	4618	548	--
2/19/71	5.4	78	8.5	7	45	56	4426	9	4381	538	0.15
2/20/71	5.8	78	8.6	7	100	75	4606	15	4506	612	--
2/21/71	6.5	74	8.7	9	100	75	4186	13	4086	532	--
2/22/71	6.7	75	8.6	12	125	100	3848	14	3723	518	--
2/23/71	7.2	70	8.7	14	160	91	3396	11	3236	341	--
2/24/71	7.3	76	8.6	8	105	86	5568	15	3463	379	--
2/25/71	5.6	75	8.2	12	60	83	3462	11	3402	411	0.14
2/26/71	4.9	81	8.1	14	85	71	3432	14	3347	528	0.1
2/27/71	5.6	76	8.0	13	85	94	3088	13	3003	609	--
2/28/71	5.2	79	8.1	17	110	86	--	--	--	545	--

TABLE B-8 RAW DATA - PLANT FINAL EFFLUENT

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	Phenol PPM
3/1/71	4.5	78	7.9	17	100	95	2998	23	2898	632	0.0
3/2/71	4.0	78	7.9	41	220	96	2970	25	2750	813	--
3/3/71	4.1	72	8.0	31	305	93	2936	21	2631	727	--
3/4/71	4.3	74	8.0	30	190	76	2876	20	2686	735	--
3/5/71	3.8	79	8.0	24	275	49	2860	21	2585	689	0.23
3/6/71	4.1	81	7.9	14	155	94	2874	16	2719	485	
3/7/71	4.4	70	7.8	10	80	81	2976	30	2896	443	--
3/8/71	4.6	67	7.7	8	380	87	3208	18	--	337	--
3/9/71	4.0	71	7.6	26	170	88	3426	12	3256	586	--
3/10/71	4.8	70	7.7	19	295	92	3692	13	3397	568	--
3/11/71	4.6	75	7.7	153	100	90	4212	7	4112	814	--
3/12/71	3.8	72	7.6	96	195	92	4544	12	4349	650	--
3/13/71	3.4	75	7.7	62	195	77	4788	12	4593	804	--
3/14/71	3.4	78	7.6	147	--	--	--	--	--	1020	--
3/15/71	3.1	77	7.4	141	365	93	4812	16	4447	923	--
3/16/71	3.8	70	7.5	70	340	71	4478	14	4138	950	--
3/17/71	4.9	70	7.6	18	230	28	4154	15	1924	782	--
3/18/71	3.6	77	7.9	11	185	73	3704	15	3519	698	--
3/19/71	5.9	70	7.8	20	190	74	3314	14	3124	607	--
3/20/71	5.1	67	7.8	20	165	74	3018	24	2853	623	--
3/21/71	5.8	72	7.8	26	160	81	3014	18	2851	645	--
3/22/71	5.8	74	8.0	13	285	77	3090	19	2015	644	0.1
3/23/71	4.0	70	8.0	27	320	39	3244	21	2924	606	0.38
3/24/71	5.0	78	8.0	127	430	42	4226	32	3796	800	--
3/25/71	5.0	66	7.9	55	905	86	4316	32	3411	739	--
3/26/71	4.5	70	7.6	--	--	--	--	--	--	636	--
3/27/71	5.3	74	7.8	--	230	55	3320	12	3090	763	--
3/28/71	6.3	87	7.7	--	190	58	--	--	--	545	--
3/29/71	4.9	70	7.6	--	170	68	2228	21	2058	554	--
3/30/71	8.8	68	7.5	--	145	55	3004	11	2859	441	0.03
3/31/71	7.5	75	7.4	--	115	61	--	--	--	439	--

TABLE C-1 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	DO Uptake	Sludge Recycle
7/30/70	6.2	84	7.0	3980	47	125	--	96	37	--
7/31/70	6.8	86	7.0	2730	40	120	--	96	--	--
8/1/70	7.0	88	7.2	1660	49	115	--	--	23	--
8/2/70	7.3	87	7.0	3480	38	105	--	96	25	--
8/3/70	6.8	86	--	3480	38	110	--	96	45	--
8/4/70	7.8	86	--	3460	41	110	--	96	27	--
8/5/70	6.0	84	7.0	3320	43	125	--	96	21	--
8/6/70	6.1	87	7.0	3140	44	125	--	96	24	--
8/7/70	6.5	84	7.2	2780	51	110	--	72	22	--
8/8/70	6.2	84	7.1	--	--	70	--	72	--	--
8/9/70	7.7	85	7.1	--	--	70	--	72	--	--
8/10/70	--	86	7.3	1300	57	70	--	Batch	--	--
8/11/70	7.2	80	7.4	1660	43	--	--	Batch	--	--
8/12/70	7.2	78	7.3	--	--	56	--	Batch	6.6	--
8/13/70	7.8	78	7.5	1600	36	55	--	Batch	6.0	--
8/14/70	7.2	83	7.2	1420	37	50	--	96	13	--
8/15/70	6.8	82	7.5	2680	38	50	--	Batch	13	--
8/16/70	6.9	87	7.5	1620	54	55	--	Batch	8	--
8/17/70	7.4	84	7.4	2380	09	50	--	Batch	13	--
8/18/70	6.9	80	7.1	--	--	40	--	96	12	--
8/19/70	7.0	82	7.0	--	--	55	--	96	13	--
8/20/70	6.9	80	7.0	1460	14	50	--	96	2.2	--
8/21/70	6.6	82	7.3	--	--	50	--	36	2.5	--
8/22/70	6.6	82	7.5	--	--	50	--	48	--	--
8/23/70	--	--	--	--	--	--	--	48	--	Batch
8/24/70	--	--	--	--	--	--	--	48	--	Batch
8/25/70	--	--	--	--	--	--	--	48	--	Batch
8/26/70	--	--	--	--	--	--	--	48	--	Batch
8/27/70	7.1	80	7.4	1660	45	--	--	24	--	46%
8/28/70	6.5	80	7.7	1100	73	30	--	24	5	Batch
8/29/70	7.2	82	7.8	1200	64	30	--	48	9	46%
8/30/70	6.5	84	7.4	1000	80	25	--	48	11	46%
8/31/70	5.0	85	7.2	1100	55	25	--	48	8.5	46%

TABLE C-2 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	F/M	DO Uptake	Sludge Recycle
9/1/70	4.8	86	7.3	1360	87	100	--	24	--	20	46%
9/2/70	6.2	85	7.6	2780	65	110	--	24	--	17	46%
9/3/70	5.0	86	7.6	2860	61	110	--	24	0.42	20	46%
9/4/70	4.1	83	7.6	2680	75	110	--	24	0.36	22	46%
9/5/70	5.4	82	7.7	2400	94	95	--	24	0.23	21	46%
9/6/70	5.5	83	7.8	2280	70	95	--	24	0.38	20	46%
9/7/70	5.8	85	8.0	2140	57	90	--	24	0.69	4.3	46%
9/8/70	6.2	82	8.1	1440	--	95	--	24	--	4	46%
9/9/70	6.0	83	7.9	2010	51	85	--	24	0.51	5.4	46%
9/10/70	6.2	84	8.1	--	--	85	--	24	--	6.4	46%
9/11/70	4.8	82	7.8	2320	75	110	--	24	0.48	15	46%
9/12/70	2.8	80	7.6	2540	52	110	--	24	0.61	22	46%
9/13/70	5.4	80	7.6	2140	58	90	--	24	0.65	12	46%
9/14/70	5.7	80	7.7	2180	59	120	--	24	--	10	46%
9/15/70	5.1	80	7.9	2280	60	140	--	24	--	18	46%
9/16/70	5.7	80	8.0	2080	50	140	--	24	--	10	46%
9/17/70	5.8	82	8.0	2180	66	150	--	24	--	8.9	46%
9/18/70	6.2	81	8.1	--	--	140	--	48	--	7.0	46%
9/19/70	4.2	85	8.1	--	--	155	--	48	--	6.0	100%
9/20/70	4.0	85	7.9	--	--	155	--	48	--	--	100%
9/21/70	4.4	88	8.0	--	--	145	--	48	--	3.0	100%
9/22/70	3.7	84	7.9	2430	73	159	62	48	--	5.1	100%
9/23/70	5.8	87	8.0	3000	65	145	47	48	--	11.0	100%
9/24/70	5.0	80	7.7	2360	72	150	64	48	0.24	15.0	100%
9/25/70	5.4	81	7.8	3930	49	160	41	48	0.25	11.0	100%
9/26/70	5.8	83	7.8	3210	67	175	55	48	0.24	16.0	100%
9/27/70	6.5	80	8.0	2960	51	170	57	48	0.22	12.0	100%
9/28/70	7.0	77	7.9	2780	--	185	67	48	--	21.0	100%
9/29/70	8.4	70	8.4	2220	75	180	81	48	0.18	6.0	100%
9/30/70	7.1	72	8.1	3650	55	190	52	24	0.71	14.0	46%

TABLE C-3 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	F/M	DO Uptake	% Sludge Recycle
10/1/70	5.8	75	7.9	3820	65	220	57	24	0.44	24.0	46
10/2/70	6.8	76	8.0	2760	61	210	56	24	0.37	14.0	46
10/3/70	6.4	78	7.9	3560	68	235	66	24	0.33	23.0	46
10/4/70	6.8	79	7.9	--	--	--	--	24	--	--	46
10/5/70	6.2	76	8.0	3560	66	235	66	24	--	39.0	46
10/6/70	7.0	74	8.1	3480	61	225	65	24	--	26.0	46
10/7/70	7.0	75	7.9	3260	66	230	70	24	0.81	24.0	46
10/8/70	7.0	76	7.9	3030	70	215	71	24	0.97	32.0	46
10/9/70	4.2	78	7.6	3020	70	210	70	24	0.54	30.0	46
10/10/70	5.4	72	7.5	2460	72	225	92	24	0.50	30.0	46
10/11/70	6.4	78	7.6	--	--	230	--	24	--	19.0	46
10/12/70	6.7	76	7.6	3040	65	250	82	24	0.45	19.0	46
10/13/70	7.2	75	7.4	3340	76	270	81	24	0.24	20.0	46
10/14/70	6.4	76	7.7	2980	76	270	92	24	0.38	16.0	46
10/15/70	7.7	75	7.7	3200	72	330	101	24	0.22	14.0	46
10/16/70	8.4	68	7.8	--	--	320	--	24	--	15.0	46
10/17/70	--	--	--	--	--	--	--	24	--	--	46
10/18/70	--	--	--	--	--	--	--	24	--	--	46
10/19/70	7.6	66	8.0	2600	73	300	115	24	0.47	6.0	46
10/20/70	9.4	66	8.1	2270	63	285	126	24	--	8.0	46
10/21/70	8.9	68	8.1	2300	70	250	108	24	--	8.0	46
10/22/70	7.6	66	8.0	1680	89	200	119	24	--	10.0	46
10/23/70	5.8	67	7.6	1430	70	150	105	24	--	21.0	46
10/24/70	6.7	70	7.9	1600	75	140	88	24	--	28.0	46
10/25/70	9.7	69	7.8	1200	67	110	72	24	1.02	28.0	46
10/26/70	10.0	71	7.6	860	81	100	116	Batch	1.73	36.0	46
10/27/70	11.6	69	7.7	1460	33	85	58	Batch	3.36	25.0	Batch
10/28/70	12.0	70	7.4	720	83	85	118	Batch	1.71	25.0	100
10/29/70	--	68	--	3080	56	295	96	Batch	--	18.0	100
10/30/70	--	68	7.8	3100	78	300	97	24	0.42	17.0	100
10/31/70	5.6	63	7.7	--	--	320	--	24	--	22.0	100

TABLE C-4 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	F/M	DO Uptake	% Sludge Recycle
11/1/70	6.3	70	7.3	3740	59	450	120	24	0.74	20	100
11/2/70	7.2	67	7.4	3560	72	330	93	24	0.32	37	100
11/3/70	9.1	59	7.3	3340	97	710	212	24	0.12	13	100
11/4/70	9.0	58	7.6	3400	49	610	179	24	0.26	18	100
11/5/70	8.6	57	7.6	9520	63	780	172	24	--	14	100
11/6/70	4.0	67	7.1	3450	81	630	182	24	--	48	100
11/7/70	4.1	67	7.6	3220	81	650	202	24	0.22	30	100
11/8/70	7.6	70	7.6	2820	81	630	224	24	--	16	100
11/9/70	7.2	72	7.8	3260	80	350	187	24	0.17	17	100
11/10/70	9.6	66	7.9	4360	74	650	149	24	--	12	100
11/11/70	7.9	63	7.7	3960	67	410	104	24	--	19	100
11/12/70	5.8	66	7.6	3760	64	725	193	24	0.37	19	100
11/13/70	9.2	68	7.6	--	--	400	--	24	--	11	100
11/14/70	7.2	66	7.6	--	--	785	--	24	--	16	100
11/15/70	--	--	--	--	--	--	--	24	--	--	100
11/16/70	6.2	58	7.9	4000	83	770	192	24	0.14	11	100
11/17/70	7.8	106	7.6	5760	66	640	111	24	0.13	23	100
11/18/70	7.2	68	7.4	5560	76	880	158	24	0.22	17	100
11/19/70	7.0	75	8.0	5400	75	898	166	24	--	6	100
11/20/70	3.2	84	7.8	4000	82	350	88	24	0.92	32	100
11/21/70	5.5	83	7.8	2000	59	150	75	24	0.99	26	100
11/22/70	6.1	85	7.7	1500	88	140	93	24	--	20	100
11/23/70	4.8	66	7.5	4620	83	950	206	24	0.58	16	100
11/24/70	5.8	76	7.5	5180	70	815	157	24	0.25	28	100
11/25/70	--	--	--	--	--	--	--	24	--	--	100
11/26/70	--	--	--	--	--	--	--	24	--	--	100
11/27/70	--	--	--	--	--	--	--	24	--	--	100
11/28/70	--	--	--	--	--	--	--	24	--	--	100
11/29/70	--	--	--	--	--	--	--	24	--	--	100
11/30/70	3.6	90	7.8	2900	72	185	64	24	0.51	22	100

TABLE C-5 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	F/M	DO Uptake	% Sludge Recycle
12/1/70	5.5	89	7.8	1760	92	175	100	24	0.76	9	100
12/2/70	4.4	85	7.4	3870	75	650	168	24	0.33	25	100
12/3/70	3.4	89	7.3	5540	76	950	172	24	0.25	17	100
12/4/70	3.5	85	7.2	6120	71	965	158	24	0.37	23	100
12/5/70	7.0	72	7.0	6400	78	965	151	24	0.05	22	100
12/6/70	6.4	68	7.3	4300	86	950	220	24	0.33	18	100
12/7/70	5.0	85	7.2	4580	78	920	201	24	0.37	29	100
12/8/70	4.6	92	7.6	4540	89	905	200	24	0.33	22	100
12/9/70	4.2	85	7.5	4500	81	950	200	36	0.13	43	100
12/10/70	4.8	81	7.6	5280	84	940	178	36	0.19	38	100
12/11/70	4.8	86	7.5	5240	80	940	180	36	0.24	36	100
12/12/70	5.8	82	7.6	5440	85	945	174	36	0.21	26	100
12/13/70	5.2	83	7.4	5220	74	950	180	36	0.15	28	100
12/14/70	5.7	84	8.0	5000	87	960	192	36	0.21	27	100
12/15/70	4.6	80	8.0	5600	84	960	172	36	0.18	28	100
12/16/70	4.7	84	7.6	5340	76	950	177	36	0.29	38	100
12/17/70	5.2	82	7.7	5420	83	970	179	36	0.23	37	100
12/18/70	1.0	83	7.8	6960	89	950	137	36	0.10	--	100
12/19/70	5.7	83	8.0	6340	87	960	150	36	0.53	50	100
12/20/70	2.2	86	7.9	6200	86	970	156	36	0.35	38	100
12/21/70	3.8	84	7.9	6380	84	960	150	Batch	--	34	--
12/22/70	4.9	87	7.8	6100	72	975	160	Batch	--	39	--
12/23/70	7.4	91	8.4	6440	79	980	152	Batch	--	36	--
12/24/70	5.3	83	8.3	6380	80	960	151	Batch	--	78	--
12/25/70	7.6	83	8.3	6340	90	970	153	Batch	--	32	--
12/26/70	9.0	72	8.5	6000	97	990	165	Batch	--	29	--
12/27/70	8.2	84	8.6	5800	81	960	165	Batch	--	26	--
12/28/70	6.8	84	8.3	6540	85	980	150	Batch	--	22	--
12/29/70	3.8	84	7.8	6660	86	970	146	Batch	--	19	--
12/30/70	2.9	83	7.8	6340	86	965	152	Batch	--	27	--
12/31/70	3.1	84	7.9	6424	80	970	150	Batch	--	25	--

TABLE C-6 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	F/M	DO Uptake	% Sludge Recycle
1/1/71	6.2	85	8.1	6500	88	960	147	Batch	--	34	--
1/2/71	5.8	86	8.0	6640	85	970	147	Batch	--	29	--
1/3/71	5.2	87	8.0	6340	86	970	152	Batch	--	30	--
1/4/71	6.1	85	8.2	--	--	--	--	Batch	--	29	--
1/5/71	6.8	80	8.2	6860	77	970	141	72	--	12	Batch
1/6/71	7.8	82	8.1	6000	84	950	158	72	--	13	Batch
1/7/71	7.0	83	7.9	4640	84	900	193	72	0.08	12	Batch
1/8/71	7.5	65	8.1	6000	78	950	158	72	0.03	12	Batch
1/9/71	4.9	83	7.9	--	--	--	--	72	--	--	Batch
1/10/71	7.8	85	7.9	4000	74	330	82	72	0.14	23	Batch
1/11/71	7.0	86	8.0	3360	84	300	87	72	0.14	48	Batch
1/12/71	1.8	86	7.5	3480	80	310	89	192	--	--	Batch
1/13/71	4.4	79	7.6	4840	76	255	52	192	0.16	42	Batch
1/14/71	5.1	90	7.6	3000	88	330	109	192	0.16	30	Batch
1/15/71	5.6	84	7.6	3220	93	370	114	192	0.08	15	Batch
1/16/71	5.8	80	7.7	2860	100	360	125	192	0.05	15	Batch
1/17/71	5.4	84	7.8	3000	83	370	123	192	0.09	18	Batch
1/18/71	5.0	87	8.2	2700	75	350	129	192	0.15	10	Batch
1/19/71	5.6	85	8.0	3080	68	335	108	192	0.11	12	Batch
1/20/71	6.0	80	8.4	2620	87	370	141	120	0.11	6	Batch
1/21/71	6.8	87	8.3	2860	90	430	150	120	0.13	10	Batch
1/22/71	2.4	90	7.5	3680	64	400	108	120	0.43	66	Batch
1/23/71	5.8	87	8.1	3740	77	395	106	120	0.20	14	Batch
1/24/71	6.4	90	8.3	3580	74	400	111	120	0.29	16	Batch
1/25/71	2.4	90	7.8	3400	79	500	147	192	0.08	22	Batch
1/26/71	3.4	89	8.0	3360	75	450	134	192	0.14	14	Batch
1/27/71	4.8	87	8.1	3600	76	565	157	192	0.11	17	Batch
1/28/71	5.2	88	7.8	3320	81	430	129	192	0.22	28	Batch
1/29/71	4.5	88	7.9	4040	91	650	160	192	--	36	Batch
1/30/71	2.2	88	7.6	4420	30	630	142	144	0.04	40	Batch
1/31/71	7.8	86	8.1	3800	82	700	184	144	0.05	20	Batch

TABLE C-7 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	F/M	DO Uptake	% Sludge Recycle
2/1/71	6.1	88	7.9	3369	83	480	121	144	0.04	7	Batch
2/2/71	6.5	87	8.2	2020	83	455	225	144	0.04	7	Batch
2/3/71	2.0	85	7.5	3320	66	515	155	144	0.29	34	Batch
2/4/71	1.6	86	7.6	3720	82	465	125	144	0.03	36	Batch
2/5/71	5.5	83	7.8	3440	76	480	139	144	0.08	8	Batch
2/6/71	2.6	83	8.6	3220	100	445	138	144	0.12	28	Batch
2/7/71	1.2	82	8.2	3320	100	375	113	144	0.05	33	Batch
2/8/71	6.2	81	8.2	2440	92	430	176	144	0.08	9	Batch
2/9/71	7.1	86	8.5	2575	85	350	136	144	0.08	8	Batch
2/10/71	7.9	88	8.9	2970	81	380	128	144	0.06	28	Batch
2/11/71	4.6	86	8.0	3133	70	345	110	96	0.10	10	Batch
2/12/71	7.3	85	8.6	4500	88	695	154	96	0.05	12	Batch
2/13/71	1.8	84	8.2	5160	80	790	153	96	0.18	36	Batch
2/14/71	5.2	86	8.3	5000	78	745	149	96	0.07	38	Batch
2/15/71	3.3	70	8.5	5200	77	830	160	96	0.08	11	Batch
2/16/71	0.4	88	8.4	5060	76	760	150	96	0.13	--	Batch
2/17/71	3.0	83	8.3	4950	76	780	157	96	0.12	16	Batch
2/18/71	5.7	83	8.3	5500	81	770	171	96	0.11	15	Batch
2/19/71	5.2	86	8.4	4390	88	795	181	96	0.12	13	Batch
2/20/71	5.4	84	8.5	5260	78	805	153	96	0.09	12	Batch
2/21/71	6.4	82	8.6	4820	81	855	177	96	0.05	--	Batch
2/22/71	6.5	84	8.7	4820	83	850	176	96	0.04	7	100
2/23/71	7.2	82	8.7	5820	88	820	140	96	0.04	5	100
2/24/71	7.3	82	8.6	4640	88	845	182	96	0.04	5	100
2/25/71	5.3	85	8.1	4800	87	840	175	48	0.23	10	100
2/26/71	4.6	86	8.1	5430	81	890	163	48	0.31	13	100
2/27/71	5.4	78	8.0	5580	83	910	163	48	0.19	11	100
2/28/71	4.5	90	8.0	5260	84	850	161	48	0.15	20	100

TABLE C-8 RAW DATA - MIXED LIQUOR IN OXIDATION TANK

Date	DO PPM	Temp. °F	pH	SS PPM	% VSS	Settling Test	SVI	Retention Time - Hours	F/M	DO Uptake	% Sludge Recycle
3/1/71	2.8	85	7.8	4770	83	640	134	48	0.18	26	100
3/2/71	4.3	85	7.8	5170	81	820	159	48	0.19	20	100
3/3/71	4.3	82	7.9	4750	86	865	182	48	0.15	12	100
3/4/71	3.9	90	7.9	4930	79	845	171	48	0.17	13	100
3/5/71	3.9	92	7.9	4850	84	730	150	48	0.14	13	100
3/6/71	2.6	90	7.3	4740	83	730	154	48	0.31	24	100
3/7/71	3.8	81	7.3	4820	85	860	178	48	0.19	17	100
3/8/71	2.8	80	7.3	4420	88	815	184	48	0.30	22	100
3/9/71	4.4	87	7.3	4780	85	820	171	48	0.24	39	100
3/10/71	3.0	78	7.0	5060	87	890	175	48	0.26	20	100
3/11/71	0.5	90	7.0	4580	87	730	159	48	0.32	--	100
3/12/71	1.3	80	7.3	5320	85	865	162	48	0.27	36	100
3/13/71	6.5	88	7.5	4020	81	510	126	48	0.54	--	100
3/14/71	1.4	80	7.3	4140	79	410	99	48	0.22	25	100
3/15/71	0.5	85	7.1	4220	74	520	123	48	0.59	--	100
3/16/71	3.8	80	7.2	4240	86	570	134	48	0.34	48	100
3/17/71	5.3	68	7.4	4550	85	700	154	48	0.26	30	100
3/18/71	5.6	83	7.4	4560	85	660	145	48	0.11	20	100
3/19/71	5.1	78	7.6	4650	85	650	140	48	0.10	26	100
3/20/71	5.8	77	7.5	9500	85	590	131	48	0.10	18	100
3/21/71	5.4	78	7.5	4730	84	670	142	48	0.20	22	100
3/22/71	5.8	82	7.6	4840	86	570	117	48	0.12	20	100
3/23/71	1.5	80	7.9	4850	82	570	117	48	0.18	48	100
3/24/71	2.8	76	7.8	5130	83	580	113	48	0.19	40	100
3/25/71	3.3	76	7.7	4510	91	440	97	48	0.12	30	100
3/26/71	3.9	70	7.5	4680	82	520	111	48	--	40	100
3/27/71	0.4	84	7.7	4250	85	330	78	48	--	32	100
3/28/71	5.5	87	7.6	4470	80	380	85	48	--	12	100
3/29/71	3.0	82	7.4	4800	80	365	76	48	--	40	100
3/30/71	5.4	73	7.4	4880	80	410	84	48	--	8	100
3/31/71	4.3	88	7.1	5120	84	455	89	48	--	19	100

TABLE D-1 RAW DATA - OX TANK PERFORMANCE

RAW DATA - WASTE SLUDGE

Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
7/30/70	91	71	--	--	--	--	--	--	--
7/31/70	93	78	--	--	--	--	--	--	--
8/1/70	89	82	--	--	--	--	--	--	--
8/2/70	93	--	--	--	--	--	--	--	--
8/3/70	99	77	--	--	--	--	--	--	--
8/4/70	98	89	--	--	--	--	--	--	--
8/5/70	99	85	--	--	--	--	--	--	--
8/6/70	89	67	77	--	--	--	--	--	--
8/7/70	90	76	--	--	--	--	--	--	--
8/8/70	99	--	--	--	--	--	--	--	--
8/9/70	--	--	--	--	--	--	--	--	--
8/10/70	92	72	--	--	--	--	--	--	--
8/11/70	--	66	90	--	--	--	--	--	--
8/12/70	--	--	--	--	--	--	--	--	--
8/13/70	--	--	55	--	--	--	--	--	--
8/14/70	--	--	--	--	--	--	--	--	--
8/15/70	--	85	--	--	--	--	--	--	--
8/16/70	--	--	--	--	--	--	--	--	--
8/17/70	--	--	--	--	--	--	--	--	--
8/18/70	--	87	98	--	--	--	--	--	--
8/19/70	--	86	--	--	--	--	--	--	--
8/20/70	--	77	97	--	--	--	--	--	--
8/21/70	--	--	--	--	--	--	--	--	--
8/22/70	98	--	--	--	--	--	--	--	--
8/23/70	--	--	--	--	--	--	--	--	--
8/24/70	--	--	--	--	--	--	--	--	--
8/25/70	--	--	--	--	--	--	--	--	--
8/26/70	--	--	--	--	--	--	--	--	--
8/27/70	--	--	--	--	--	--	--	--	--
8/28/70	99	96	--	--	--	--	--	--	--
8/29/70	68	--	--	--	--	--	--	--	--
8/30/70	18	39	--	--	--	--	--	--	--
8/31/70	46	--	--	--	--	--	--	--	--

TABLE D-2 RAW DATA - OX TANK PERFORMANCE

RAW DATA - WASTE SLUDGE

Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
9/1/70	46	42	99	--	--	--	--	--	--
9/2/70	42	--	--	--	--	--	--	--	--
9/3/70	12	59	98	--	--	--	--	--	--
9/4/70	45	33	--	--	--	--	--	--	--
9/5/70	40	30	--	--	--	--	--	--	--
9/6/70	49	38	--	--	--	--	--	--	--
9/7/70	49	40	--	--	--	--	--	--	--
9/8/70	39	27	99	--	--	--	--	--	--
9/9/70	40	29	--	--	--	--	--	--	--
9/10/70	--	--	--	--	--	--	--	--	--
9/11/70	60	49	--	--	--	--	--	--	--
9/12/70	28	15	--	--	--	--	--	--	--
9/13/70	39	--	--	--	--	--	--	--	--
9/14/70	--	27	--	--	--	--	--	--	--
9/15/70	--	47	--	--	--	--	--	--	--
9/16/70	--	33	--	--	--	--	--	--	--
9/17/70	--	30	--	--	--	--	--	--	--
9/18/70	--	--	--	--	--	--	--	--	--
9/19/70	--	--	--	--	--	--	--	--	--
9/20/70	--	--	--	--	--	--	--	--	--
9/21/70	--	--	--	--	--	--	--	--	--
9/22/70	--	--	--	--	--	--	--	--	--
9/23/70	--	--	--	--	--	--	--	--	--
9/24/70	85	72.5	--	--	--	--	--	--	--
9/25/70	88	76	100	--	--	--	--	--	--
9/26/70	87	78	--	--	--	--	--	--	--
9/27/70	85	79	--	--	--	--	--	--	--
9/28/70	79	66	--	200	2120	--	--	--	--
9/29/70	84	57	99	--	--	--	--	--	--
9/30/70	86	68	--	--	--	--	--	--	--

TABLE D-3 RAW DATA - OX TANK PERFORMANCE

RAW DATA - WASTE SLUDGE

Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
10/1/70	90	67	99	--	--	--	--	--	--
10/2/70	80	48	--	--	--	--	--	--	--
10/3/70	71	85.8	--	--	--	--	--	--	--
10/4/70	--	--	--	--	--	--	--	--	--
10/5/70	--	--	--	--	--	--	--	--	--
10/6/70	--	55	--	--	--	--	--	--	--
10/7/70	51	45	--	--	--	--	--	--	--
10/8/70	77	--	--	--	--	--	--	--	--
10/9/70	65	2.0	--	--	--	--	--	--	--
10/10/70	32	25	--	--	--	--	--	--	--
10/11/70	--	--	--	--	--	--	--	--	--
10/12/70	61.7	44	--	--	--	--	--	--	--
10/13/70	50	32	--	--	--	--	--	--	--
10/14/70	72.6	32	99.9	--	--	--	--	--	--
10/15/70	32.4	40	--	--	--	--	--	--	--
10/16/70	--	--	--	--	--	--	--	--	--
10/17/70	--	42	--	--	--	--	--	--	--
10/18/70	--	--	--	--	--	--	--	--	--
10/19/70	75	--	--	--	--	--	--	--	--
10/20/70	--	--	--	--	--	--	--	--	--
10/21/70	--	12	--	--	--	--	--	--	--
10/22/70	--	44	--	--	--	--	--	--	--
10/23/70	--	67	--	--	--	--	--	--	--
10/24/70	--	32	--	--	--	--	--	--	--
10/25/70	75	45	--	--	--	--	--	--	--
10/26/70	70	45	--	--	--	--	--	--	--
10/27/70	67	47	--	--	--	--	--	--	--
10/28/70	72	58	--	--	--	--	--	--	--
10/29/70	--	--	--	--	--	--	--	--	--
10/30/70	75	--	--	--	--	--	--	--	--
10/31/70	--	--	--	--	--	--	--	--	--

TABLE D-4 RAW DATA - OX TANK PERFORMANCE

RAW DATA - WASTE SLUDGE

Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
11/1/70	46	--	--	--	--	--	--	--	--
11/2/70	44	--	--	--	--	--	--	--	--
11/3/70	54	10	98	--	--	--	--	--	--
11/4/70	71	36	--	--	--	--	--	--	--
11/5/70	--	45	--	--	--	--	--	--	--
11/6/70	--	--	--	--	--	--	--	--	--
11/7/70	0	0	--	--	--	--	--	--	--
11/8/70	14	0	--	--	--	--	--	--	--
11/9/70	48	44	--	--	--	--	--	--	--
11/10/70	--	--	--	--	--	--	--	--	--
11/11/70	--	76	--	--	--	--	--	--	--
11/12/70	92	58	--	--	--	--	--	--	--
11/13/70	--	--	--	150	--	--	--	--	--
11/14/70	--	71	--	--	--	--	--	--	--
11/15/70	--	--	--	--	--	--	--	--	--
11/16/70	86	71	--	50	--	--	--	--	--
11/17/70	--	57	99.5	200	--	--	58171	81	--
11/18/70	--	72	--	--	--	--	--	--	--
11/19/70	--	66	--	50	--	--	14270	66	--
11/20/70	95	88	99+	--	--	--	--	--	--
11/21/70	74	55	--	--	--	--	--	--	--
11/22/70	90	--	--	--	--	--	--	--	--
11/23/70	77	58	--	--	--	--	--	--	--
11/24/70	53	--	99.8	--	--	--	--	--	--
11/25/70	--	--	--	--	--	--	--	--	--
11/26/70	--	--	--	--	--	--	--	--	--
11/27/70	--	--	--	--	--	--	--	--	--
11/28/70	--	--	--	--	--	--	--	--	--
11/29/70	--	--	--	--	--	--	--	--	--
11/30/70	75	73	--	--	--	--	--	--	--

TABLE D-5 RAW DATA - OX TANK PERFORMANCE

RAW DATA - WASTE SLUDGE

Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
12/1/70	79	61	88.5	--	--	--	--	--	--
12/2/70	62	44	--	--	--	--	--	--	--
12/3/70	81	71	99.5	100	--	--	17318	73	--
12/4/70	82	81	--	300	--	--	14808	71	--
12/5/70	0	84	--	600	--	--	12103	67	--
12/6/70	67	60	--	--	--	--	--	--	--
12/7/70	65	54	--	--	--	--	--	--	--
12/8/70	60	46	99.8	--	--	--	--	--	--
12/9/70	55	62	--	--	--	--	--	--	--
12/10/70	77	54	--	--	--	--	--	--	--
12/11/70	56	50	--	--	--	--	--	--	--
12/12/70	71	50	--	--	--	--	--	--	--
12/13/70	63	61	--	--	--	--	--	--	--
12/14/70	75	42	--	100	--	--	--	--	--
12/15/70	66	55	--	--	--	--	--	--	--
12/16/70	76	70	--	--	--	--	--	--	--
12/17/70	80	55	--	--	--	--	--	--	--
12/18/70	82	80	--	--	--	--	--	--	--
12/19/70	91	89	--	--	--	--	--	--	--
12/20/70	81	48	--	--	--	--	--	--	--
12/21/70	--	--	--	--	--	--	--	--	--
12/22/70	--	--	--	--	--	--	--	--	--
12/23/70	--	--	--	--	--	--	--	--	--
12/24/70	--	--	--	--	--	--	--	--	--
12/25/70	--	--	--	--	--	--	--	--	--
12/26/70	--	--	--	--	--	--	--	--	--
12/27/70	--	--	--	--	--	--	--	--	--
12/28/70	--	--	--	--	--	--	--	--	--
12/29/70	--	--	--	--	--	--	--	--	--
12/30/70	--	--	--	--	--	--	--	--	--
12/31/70	--	--	--	--	--	--	--	--	--

TABLE D-6 RAW DATA - OX TANK PERFORMANCE

				RAW DATA - WASTE SLUDGE					
Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
1/1/71	--	--	--	--	--	--	--	--	--
1/2/71	--	--	--	--	--	--	--	--	--
1/3/71	--	--	--	--	--	--	--	--	--
1/4/71	--	--	--	--	--	--	--	--	--
1/5/71	--	--	--	--	--	--	--	--	--
1/6/71	--	--	--	--	--	--	--	--	--
1/7/71	81	67	--	--	--	--	--	--	--
1/8/71	93	65	--	--	--	--	--	--	--
1/9/71	--	--	--	--	--	--	--	--	--
1/10/71	95	73	--	--	--	--	--	--	--
1/11/71	100	88	--	--	--	--	--	--	--
1/12/71	--	--	--	--	--	--	--	--	--
1/13/71	76	30	--	--	--	--	--	--	--
1/14/71	81	37	--	--	--	--	--	--	--
1/15/71	82	48	--	--	--	--	--	--	--
1/16/71	81	50	--	--	--	--	--	--	--
1/17/71	78	61	--	--	--	--	--	--	--
1/18/71	78	64	--	--	--	--	--	--	--
1/19/71	80	64	99+	--	--	--	--	--	--
1/20/71	72	68	99+	--	--	--	--	--	--
1/21/71	72	62	--	--	--	--	--	--	--
1/22/71	63	74	--	--	--	--	--	--	--
1/23/71	73	67	--	--	--	--	--	--	--
1/24/71	63	38	--	--	--	--	--	--	--
1/25/71	73	67	99+	--	--	--	--	--	--
1/26/71	79	81	--	--	--	--	--	--	--
1/27/71	83	74	--	--	--	--	--	--	--
1/28/71	96	92	--	--	--	--	--	--	--
1/29/71	--	--	--	--	--	--	--	--	--
1/30/71	--	--	--	--	--	--	--	--	--
1/31/71	--	--	--	--	--	--	--	--	--

TABLE D-7 RAW DATA - OX TANK PERFORMANCE

RAW DATA - WASTE SLUDGE

Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
2/1/71	82	70	--	--	--	--	--	--	--
2/2/71	92	65	--	--	--	--	--	--	--
2/3/71	95	81	--	--	--	--	--	--	--
2/4/71	95	96	--	--	--	--	--	--	--
2/5/71	96	84	--	--	--	--	59%	--	--
2/6/71	93	77	--	70	12740	78	15660	--	--
2/7/71	91	93	--	--	--	--	--	--	--
2/8/71	91	74	--	--	--	--	--	--	--
2/9/71	95	71	--	--	--	--	--	--	--
2/10/71	91	78	--	--	--	--	--	--	--
2/11/71	98	82	--	--	--	--	--	--	--
2/12/71	98	95	--	--	--	--	--	--	--
2/13/71	96	81	--	--	--	--	--	--	--
2/14/71	99	81	--	--	--	--	--	--	--
2/15/71	99	82	--	--	--	--	--	--	--
2/16/71	98	84	99.9	20	--	--	--	--	--
2/17/71	99	76	--	--	--	--	--	--	--
2/18/71	99	87	--	20	--	--	--	--	--
2/19/71	99.6	85	99.9	--	--	--	--	--	--
2/20/71	99.5	83	--	--	--	--	--	--	--
2/21/71	99	83	--	--	--	--	--	--	--
2/22/71	99	80	--	--	--	--	--	--	--
2/23/71	98	82	--	--	--	--	--	--	--
2/24/71	99	72	--	--	--	--	--	--	--
2/25/71	99	86	99.9	--	--	--	--	--	--
2/26/71	99	85	99.9	--	--	--	--	--	--
2/27/71	99	86	--	800	5580	83	--	--	1.2
2/28/71	99	85	--	500	5260	84	--	--	0.42

TABLE D-8 RAW DATA - OX TANK PERFORMANCE

RAW DATA - WASTE SLUDGE

Date	% BOD_5 Removal	% COD Removal	% Phenol Removal	Gallons Per Day	SS PPM	% VSS	TS PPM	% VTS	# Solids Per # BOD_5 Removed
3/1/71	99	83	100	--	--	--	--	--	--
3/2/71	97	80	--	500	5170	81	--	--	1.1
3/3/71	98	78	--	500	4750	80	--	--	0.33
3/4/71	98	97	--	500	4930	79	--	--	1.0
3/5/71	98	75	99.9	200	4850	84	--	--	0.4
3/6/71	99	87	--	300	4740	83	--	--	0.19
3/7/71	99.6	90	--	700	4820	85	--	--	0.76
3/8/71	99.6	94	--	--	--	--	--	--	--
3/9/71	99	90	--	--	--	--	--	--	--
3/10/71	99	87	--	500	5060	87	--	--	0.75
3/11/71	94	83	--	--	--	--	--	--	--
3/12/71	96	87	--	600	5320	85	--	--	1.7
3/13/71	98	86	--	--	--	--	--	--	--
3/14/71	94	81	--	--	--	--	--	--	--
3/15/71	94	80	--	--	--	--	--	--	--
3/16/71	98	82	--	--	--	--	--	--	--
3/17/71	99.8	84	--	--	--	--	--	--	--
3/18/71	99	80	--	--	--	--	--	--	--
3/19/71	97	74	--	--	--	--	--	--	--
3/20/71	97	73	--	--	--	--	--	--	--
3/21/71	98	76	--	--	--	--	--	--	--
3/22/71	99	78	99.9	200	4840	86	--	--	--
3/23/71	98	82	99.9	--	--	--	--	--	--
3/24/71	92	80	--	500	4850	82	--	--	--
3/25/71	96	79	--	--	--	--	--	--	--
3/26/71	--	77	--	500	4680	82	--	--	--
3/27/71	--	76	--	--	--	--	--	--	--
3/28/71	--	85	--	--	--	--	--	--	--
3/29/71	--	84	--	--	--	--	--	--	--
3/30/71	--	85	99.9	--	--	--	--	--	--
3/31/71	--	83	--	--	--	--	--	--	--

TABLE E-1 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART I

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
7/30/70	2.8	90	7.9	1066	48	92	--	--	--	--	--	--
7/31/70	6.2	86	7.8	1096	248	--	--	--	--	--	--	--
8/1/70	4.3	91	8.0	1144	28	85	--	--	--	1523	--	--
8/2/70	4.2	91	7.6	1598	20	17	--	--	--	--	--	--
8/3/70	6.4	86	7.9	488	56	36	--	--	--	--	--	--
8/4/70	0.4	91	7.7	776	92	57	--	--	--	1900	--	--
8/5/70	1.6	93	7.8	806	84	66	--	--	--	1320	--	--
8/6/70	1.8	91	7.6	640	88	77	2492	--	2404	3064	112	-
8/7/70	3.7	86	7.6	740	64	100	--	--	--	1715	--	--
8/8/70	5.6	84	8.0	664	--	--	--	--	--	--	--	--
8/9/70	6.2	84	9.7	510	--	--	--	--	--	--	--	--
8/10/70	--	86	7.3	--	120	80	--	--	--	1375	--	--
8/11/70	0.8	82	7.8	--	84	14	2718	22	2634	1750	--	--
8/12/70	3.5	84	7.9	485	112	64	2054	30	1990	1490	--	--
8/13/70	4.4	86	7.7	465	112	57	2138	--	2016	1530	--	--
8/14/70	0.8	84	7.9	670	104	50	2752	20	2702	1980	--	--
8/15/70	6.8	85	11.1	735	132	55	3448	26	3316	2120	--	--
8/16/70	6.5	87	10.9	--	--	--	--	--	--	--	--	--
8/17/70	7.0	90	9.9	--	140	82	2604	25	2664	2140	--	--
8/18/70	1.9	84	8.9	--	--	--	2466	--	--	1780	--	--
8/19/70	5.2	87	8.0	--	108	100	2246	24	2138	1725	--	--
8/20/70	0.9	87	8.2	--	72	83	2916	20	2844	--	--	--
8/21/70	1.2	87	7.7	--	--	--	--	--	--	--	--	--
8/22/70	2.6	84	7.7	504	--	--	--	--	--	--	--	--
8/23/70	--	--	--	--	--	--	--	--	--	--	--	--
8/24/70	--	--	--	--	--	--	--	--	--	--	--	--
8/25/70	--	--	--	--	--	--	--	--	--	--	--	--
8/26/70	--	--	--	--	--	--	--	--	--	--	--	--
8/27/70	2.2	87	10.0	--	85	53	--	--	--	--	--	--
8/28/70	4.8	86	9.3	2647	175	74	6700	34	6626	6520	--	--
8/29/70	6.1	87	9.7	2160	215	54	6104	33	5889	--	--	40
8/30/70	0.9	89	9.0	2100	165	--	5640	--	4575	5749	180	80
8/31/70	1.1	91	9.3	1920	195	68	--	--	--	--	247.1	--

TABLE E-2 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART I

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
9/1/70	0.5	90	8.4	1900	185	94	4924	--	4830	4015	--	--
9/2/70	0.2	87	8.6	1560	112	36	4102	--	3990	--	--	--
9/3/70	0.3	89	8.4	2553	155	77	5816	17	5739	3540	196	80
9/4/70	3.6	86	7.9	1920	80	63	6038	10	5958	4600	236	--
9/5/70	3.5	89	7.5	3100	60	58	9336	32	9276	6760	168.3	--
9/6/70	3.7	86	7.9	1400	130	60	--	--	--	6200	260.9	--
9/7/70	1.0	91	9.3	1605	15	100	6150	19	6145	5070	218.8	220
9/8/70	1.0	88	9.2	2033	332	82	6150	22	5818	5520	--	--
9/9/70	0.8	86	9.0	2052	350	21	6260	31	5910	5260	274.8	180
9/10/70	1.0	90	9.0	--	--	--	--	--	--	--	--	--
9/11/70	0.0	84	7.9	1575	280	66	6480	24	6200	5920	--	--
9/12/70	0.0	84	8.7	3050	--	--	7244	18	--	3800	--	960
9/13/70	0.6	86	10.0	1530	156	31	5724	18	5568	4100	--	--
9/14/70	6.0	88	11.0	1790	12	100	6818	21	6806	5800	--	--
9/15/70	5.9	83	10.4	2400	136	59	5600	--	5464	3610	49.0	321.2
9/16/70	2.7	83	10.4	1500	252	72	4580	--	4328	4240	--	--
9/17/70	1.2	84	10.3	613	136	88	5460	--	--	4210	--	--
9/18/70	0.9	83	10.0	--	--	--	--	--	--	--	--	--
9/19/70	5.2	80	10.7	--	--	--	--	--	--	--	--	--
9/20/70	4.0	88	10.0	--	--	--	--	--	--	--	--	--
9/21/70	3.4	91	9.6	--	--	--	--	--	--	--	--	--
9/22/70	4.4	88	11.2	--	--	--	--	--	--	--	--	--
9/23/70	6.0	86	11.8	--	--	--	--	--	--	--	--	--
9/24/70	2.1	82	10.9	3693	96	92	10558	18	10462	8460	--	--
9/25/70	3.3	92	10.8	3687	225	42	10082	11	10040	8450	--	--
9/26/70	5.6	89	11.4	3513	150	93	8492	32	8342	7090	--	--
9/27/70	5.5	80	11.5	2020	--	--	--	--	--	7700	--	--
9/28/70	2.6	82	10.9	2813	32	0	7260	25	7235	5300	2.2	329.4
9/29/70	7.0	80	11.6	--	--	--	--	--	--	4390	--	--
9/30/70	0.74	85	10.1	4935	150	22	11734	17	11584	8850	--	--

TABLE E-3 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART I

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
10/1/70	3.2	84	11.4	2439	50	70	9236	25	9186	6205	--	--
10/2/70	3.8	85	11.5	2526	10	50	9302	24	9292	6220	--	--
10/3/70	4.4	83	11.2	2322	60	25	8330	19	8270	5810	--	--
10/4/70	5.0	80	11.0	--	--	--	--	--	--	--	--	--
10/5/70	2.0	82	10.2	--	35	100	13420	23	13385	--	--	--
10/6/70	2.7	84	9.3	--	115	56	9374	22	9259	79950	--	--
10/7/70	1.4	80	11.1	6375	75	73	14200	19	14127	14050	--	--
10/8/70	1.8	80	10.2	6600	200	100	11226	8	11206	--	--	--
10/9/70	1.8	77	9.2	--	135	67	10004	20	9937	8750	--	--
10/10/70	7.0	82	9.0	2362	15	100	7594	28	9579	6650	--	--
10/11/70	6.6	86	9.7	--	--	--	--	--	--	--	--	--
10/12/70	1.2	84	8.5	3720	205	68	8552	22	8347	8100	43.4	210.4
10/13/70	4.7	82	10.2	1946	135	37	5994	27	5859	5175	--	--
10/14/70	6.8	83	11.0	3620	65	77	--	--	--	5210	42.4	347.8
10/15/70	7.2	77	11.2	1710	55	91	--	--	--	3720	--	--
10/16/70	7.8	75	11.2	--	--	--	--	--	--	--	--	--
10/17/70	--	--	--	--	--	--	--	--	--	4840	--	--
10/18/70	--	--	--	--	--	--	--	--	--	--	--	--
10/19/70	8.2	71	11.8	2319	20	75	--	--	--	--	--	--
10/20/70	9.6	66	11.7	--	45	44	--	--	--	--	--	--
10/21/70	8.8	70	11.6	--	--	--	--	--	--	--	--	--
10/22/70	7.8	66	8.0	--	185	81	--	--	--	--	--	--
10/23/70	7.7	78	9.3	--	10	100	8486	24	8476	--	--	--
10/24/70	8.8	78	10.9	--	170	80	--	--	--	4630	--	--
10/25/70	3.8	78	8.3	2075	--	--	--	--	--	5100	44	151
10/26/70	9.2	82	8.4	4500	5	10	7584	37	7574	7200	39	137
10/27/70	9.8	76	5.6	6320	55	36	--	--	--	9590	--	--
10/28/70	11.4	78	5.8	4200	5	0	4102	63	4097	8150	--	--
10/29/70	--	--	--	--	--	--	--	--	--	--	--	--
10/30/70	--	72	8.6	2505	80	100	--	--	--	--	--	--
10/31/70	0.5	73	9.1	--	--	--	--	--	--	--	--	--

TABLE E-4 RAW DATA - EQUALIZED RAW FEED TO PLANT, PLART I

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
11/1/70	4.7	68	7.3	1720	95	26	--	--	--	--	--	--
11/2/70	6.2	70	6.9	1164	64	0	3664	35	3600	3280	--	--
11/3/70	8.8	65	8.4	1253	65	100	2964	40	2899	3340	80.7	257.6
11/4/70	9.8	70	4.6	2952	160	0	28270	39	28110	8280	--	--
11/5/70	8.8	70	8.4	--	305	0	9240	0	8935	7900	--	--
11/6/70	--	--	--	--	--	--	--	--	--	--	--	--
11/7/70	9.0	77	10.8	1082	90	100	--	--	--	1082	--	--
11/8/70	6.5	79	11.0	415	--	--	--	--	--	--	--	--
11/9/70	9.4	82	11.2	810	75	60	--	--	1760	1760	--	--
11/10/70	8.6	79	9.9	--	60	0	3032	20	2972	2490	--	--
11/11/70	8.8	98	11.8	980	55	100	2986	24	2931	2040	--	--
11/12/70	--	--	--	--	--	--	--	--	--	--	--	--
11/13/70	--	--	--	--	--	--	--	--	--	--	--	--
11/14/70	--	--	--	--	--	--	--	--	--	--	--	--
11/15/70	--	--	--	340	20	80	1448	45	1128	1265	41.2	104
11/16/70	8.4	50	10.7	675	60	92	2384	27	2824	1890	--	--
11/17/70	6.2	58	10.3	1180	95	26	4052	37	3957	3800	--	--
11/18/70	4.9	60	9.6	--	50	40	4170	25	4120	3500	--	--
11/19/70	3.3	62	9.7	1260	25	100	3658	26	3633	2940	--	--
11/20/70	4.8	--	9.6	1110	90	78	3684	22	3594	3050	--	--
11/21/70	7.7	--	7.1	855	--	--	--	--	--	--	--	--
11/22/70	4.2	--	8.7	2410	66	46	5312	24	5266	5060	--	--
11/23/70	8.8	--	8.2	970	--	--	--	--	--	--	--	--
11/24/70	--	--	--	--	--	--	--	--	--	--	--	--
11/25/70	--	--	--	--	--	--	--	--	--	--	--	--
11/26/70	--	--	--	--	--	--	--	--	--	--	--	--
11/27/70	--	--	--	--	--	--	--	--	--	--	--	--
11/28/70	--	--	--	--	--	--	--	--	--	--	--	--
11/29/70	6.6	--	8.6	1140	95	90	2798	32	2703	2500	--	--
11/30/70	7.8	--	8.7	1133	255	37	2600	38	2563	2660	--	--

TABLE E-5 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART I

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
12/1/70	7.4	--	10.8	1077	115	87	1540	32	2425	2520	1.6	15.4
12/2/70	9.8	--	8.3	1380	235	34	3360	27	3125	3340	70.5	6.7
12/3/70	8.9	68	7.1	1820	75	0	3524	22	3449	3760	70.5	12.4
12/4/70	9.6	--	10.5	690	160	63	2656	30	2496	2130	70.5	--
12/5/70	9.2	--	9.3	1333	285	70	2710	10	2425	2560	70.5	--
12/6/70	8.4	--	9.2	1605	25	100	3930	20	3905	3830	70.6	--
12/7/70	7.5	--	11.5	1525	235	60	4198	33	3963	3170	1.9	--
12/8/70	7.8	--	11.7	930	0	--	4892	25	3160	3160	--	--
12/9/70	8.4	--	11.2	1395	210	100	4030	30	3820	3200	--	--
12/10/70	8.3	--	10.4	1995	45	67	3870	29	3825	3320	--	--
12/11/70	8.5	--	9.6	1580	125	72	4244	24	9119	3440	--	--
12/12/70	7.8	--	9.8	1392	80	75	--	--	--	2890	--	--
12/13/70	8.4	--	10.9	1600	125	100	5732	24	3607	3470	--	--
12/14/70	9.4	--	11.1	1310	115	56	3514	25	3399	2725	--	--
12/15/70	8.4	--	11.6	1750	60	100	4500	22	4440	3625	--	--
12/16/70	6.0	--	11.7	925	100	55	2398	39	2298	1750	--	--
12/17/70	6.2	--	10.2	1180	60	100	4446	18	4368	2745	--	--
12/18/70	8.3	--	11.1	--	--	--	--	--	--	2120	--	--
12/19/70	7.4	--	10.9	--	--	--	--	--	--	3500	--	--
12/20/70	--	--	--	--	--	--	--	--	--	--	--	--
12/21/70	--	--	--	--	--	--	--	--	--	--	--	--
12/22/70	--	--	--	--	--	--	--	--	--	--	--	--
12/23/70	--	--	--	--	--	--	--	--	--	--	--	--
12/24/70	--	--	--	--	--	--	--	--	--	--	--	--
12/25/70	--	--	--	--	--	--	--	--	--	--	--	--
12/26/70	--	--	--	--	--	--	--	--	--	--	--	--
12/27/70	--	--	--	--	--	--	--	--	--	--	--	--
12/28/70	--	--	--	--	--	--	--	--	--	--	--	--
12/29/70	--	--	--	--	--	--	--	--	--	--	--	--
12/30/70	--	--	--	--	--	--	--	--	--	--	--	--
12/31/70	--	--	--	--	--	--	--	--	--	--	--	--

TABLE E-6 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART I

Date	DO PPM	Temp. °F	pH	BOD_5 PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
1/1/71	--	--	--	--	--	--	--	--	--	--	--	--
1/2/71	--	--	--	--	--	--	--	--	--	--	--	--
1/3/71	--	--	--	--	--	--	--	--	--	--	--	--
1/4/71	--	--	--	--	--	--	--	--	--	--	--	--
1/5/71	--	--	--	--	--	--	--	--	--	--	--	--
1/6/71	8.9	--	9.9	1050	150	90	2208	21	2058	2210	--	--
1/7/71	8.6	--	10.5	405	--	--	--	--	--	930	--	--
1/8/71	--	--	--	648	--	--	--	--	--	--	--	--
1/9/71	6.9	--	10.8	1343	110	100	--	--	--	3900	--	--
1/10/71	3.4	--	8.3	3170	100	100	--	--	--	7350	--	--
1/11/71	1.7	--	8.0	--	180	100	--	--	--	--	--	--
1/12/71	5.6	--	11.0	4500	100	90	--	--	--	6298	--	--
1/13/71	5.6	--	8.0	3015	40	100	8820	34	8780	2500	--	--
1/14/71	2.6	--	9.4	3480	75	89	9810	46	9715	9560	--	--
1/15/71	4.4	--	9.2	360	75	33	846	41	971	923	--	--
1/16/71	5.4	--	4.3	1450	120	100	4772	30	4652	4213	--	--
1/17/71	1.6	--	10.0	1980	90	100	4704	29	4614	4484	--	--
1/18/71	3.6	--	10.7	2235	130	33	8152	20	8033	6151	--	--
1/19/71	5.8	--	11.1	1005	--	--	3654	43	--	3649	1.6	63.6
1/20/71	5.4	--	10.3	1710	65	100	5598	54	5533	3453	0.6	36.1
1/21/71	4.1	--	11.2	2779	325	58	--	--	--	5330	--	--
1/22/71	1.1	--	11.0	1470	150	43	--	--	--	4313	--	--
1/23/71	1.2	--	11.1	2650	45	45	5532	20	5487	3750	--	--
1/24/71	3.8	--	9.7	3675	195	54	--	--	--	7918	--	--
1/25/71	6.0	--	11.1	1545	35	0	--	--	--	4084	--	--
1/26/71	6.5	--	9.3	2010	205	56	--	--	--	5947	--	--
1/27/71	6.1	--	10.2	1160	65	69	3694	24	3629	3514	--	--
1/28/71	--	--	--	--	--	--	--	--	--	4067	--	--
1/29/71	5.7	--	11.0	718	45	64	--	--	--	2800	--	--
1/30/71	5.1	--	9.5	942	45	11	1108	65	1063	2600	--	--
1/31/71	3.8	--	11.8	700	140	46	3090	36	2950	2670	--	--

TABLE E-7 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART I

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
2/1/71	8.3	--	11.5	380	75	7	2160	46	2085	1732	--	--
2/2/71	4.8	--	9.1	1580	85	6	3170	36	3085	3792	--	--
2/3/71	6.3	--	11.3	565	15	100	2566	37	2551	2180	--	--
2/4/71	6.0	--	10.9	1080	65	0	2860	39	2795	2702	--	--
2/5/71	4.7	--	12.4	2140	85	100	7242	18	9157	6020	--	--
2/6/71	4.8	-	12.1	1957	185	100	7642	23	7457	5452	--	--
2/7/71	6.0	--	12.3	930	20	25	8700	29	8680	2736	--	--
2/8/71	7.2	--	12.0	982	765	71	7478	46	6713	5759	--	--
2/9/71	7.4	--	12.1	541	320	53	2824	39	2504	2179	--	--
2/10/71	9.7	--	11.9	653	--	--	2600	37	--	1778	--	--
2/11/71	8.8	--	11.8	2400	105	86	3736	39	3631	4742	--	--
2/12/71	6.0	--	11.9	2300	345	93	7206	50	6861	5580	--	--
2/13/71	4.9	--	11.7	1207	500	71	4084	42	3584	3848	--	--
2/14/71	5.7	--	11.6	1107	120	50	3798	38	3678	3166	--	--
2/15/71	5.4	--	11.1	1440	115	43	4028	36	3913	3169	--	--
2/16/71	1.9	--	11.3	1890	90	56	5164	29	5074	4114	--	--
2/17/71	1.2	--	10.8	2154	50	90	5750	17	5700	3881	--	--
2/18/71	2.7	--	11.6	1350	140	100	3806	18	3666	2971	--	--
2/19/71	3.1	--	11.4	1185	120	63	3834	25	3714	2799	--	--
2/20/71	5.0	--	11.1	1038	40	80	2900	19	2500	2157	--	--
2/21/71	--	--	--	--	--	--	--	--	--	--	--	--
2/22/71	Flood	--	--	--	--	--	--	--	--	--	--	--
2/23/71	Flood	--	--	--	--	--	--	--	--	--	--	--
2/24/71	Flood	--	--	--	--	--	--	--	--	--	--	--
2/25/71	4.5	--	11.9	1105	65	62	3200	29	3135	2880	--	--
2/26/71	8.4	--	11.2	855	70	63	2704	16	2694	1966	--	--
2/27/71	8.1	--	10.6	1115	80	13	--	--	--	2581	--	--
2/28/71	4.7	--	10.7	1490	360	37	--	--	--	5712	--	--

TABLE E-8 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART I

Date	DO PPM	Temp. °F	pH	BOD$_5$ PPM	SS PPM	% VSS	TS PPM	% VTS	DS PPM	COD PPM	P PPM	N PPM
3/1/71	5.7	--	10.3	1830	135	67	--	--	--	4067	--	--
3/2/71	Flood	--	--	--	--	--	--	--	--	--	--	--
3/3/71	Flood	--	--	--	--	--	--	--	--	--	--	--
3/4/71	0.1	--	5.5	965	50	70	--	--	--	1538	--	--
3/5/71	1.8	--	10.5	1985	105	90	--	--	--	4224	--	--
3/6/71	0.8	--	11.5	1747	15	67	--	--	--	4262	--	--
3/7/71	3.2	--	8.8	5040	40	87	10234	28	10194	7808	--	--
3/8/71	2.6	--	9.9	3270	165	76	8884	16	8719	6827	--	--
3/9/71	2.2	--	11.0	2340	115	96	3412	27	3297	2916	--	--
3/10/71	1.7	--	8.3	4245	130	81	8448	16	8318	8758	--	--
3/11/71	1.6	--	10.0	3022	50	90	8058	16	8008	5934	--	--
3/12/71	2.2	--	11.1	3555	125	48	8570	17	8465	7647	--	--
3/13/71	1.9	--	10.3	1475	--	--	--	--	--	2916	--	--
3/14/71	1.6	--	5.3	4732	10	50	9178	17	9163	7795	--	--
3/15/71	6.5	--	10.0	1102	800	70	3014	26	2214	3790	--	--
3/16/71	8.6	--	11.7	922	165	45	3614	25	3449	2986	--	--
3/17/71	9.6	--	11.4	471	190	42	2776	39	2586	1997	--	--
3/18/71	9.2	--	11.1	684	300	48	2828	48	2528	2199	--	--
3/19/71	9.4	--	11.4	1248	260	87	2874	36	2614	3489	--	--
3/20/71	8.7	--	11.7	1725	275	53	3818	31	3543	3342	--	--
3/21/71	9.0	--	11.8	872	195	74	4340	34	4145	2818	--	--
3/22/71	5.8	--	12.0	2640	305	61	7655	15	7261	4916	--	--
3/23/71	4.4	--	12.0	1950	95	94	6000	18	5905	4465	--	--
3/24/71	7.6	--	10.8	933	10	50	2840	33	2830	2368	--	--
3/25/71	7.0	--	10.5	--	--	--	--	--	--	3056	--	--
3/26/71	5.4	--	11.8	--	75	73	2750	18	2675	3467	--	--
3/27/71	0.2	--	6.3	--	--	--	--	--	--	4505	--	--
3/28/71	5.0	--	10.1	--	--	--	2228	21	--	2656	--	--
3/29/71	5.9	--	10.1	--	100	40	2196	22	2096	2182	--	--
3/30/71	2.6	--	9.8	--	155	77	--	--	--	2665	--	--
3/31/71	--	--	--	--	--	--	--	--	--	--	--	--

TABLE F-1 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
7/30/70	--	--	--	--	--	--	--	--	--
7/31/70	--	--	--	--	--	--	--	--	--
8/1/70	--	--	--	--	--	--	--	--	--
8/2/70	--	--	--	--	--	--	--	--	--
8/3/70	--	--	--	--	--	--	--	--	--
8/4/70	--	--	--	--	--	--	--	--	--
8/5/70	--	--	--	--	--	--	--	--	--
8/6/70	--	--	--	--	--	31.8	--	--	--
8/7/70	--	--	--	--	--	--	--	--	--
8/8/70	--	--	--	--	--	--	--	--	--
8/9/70	--	--	--	--	--	--	--	--	--
8/10/70	--	--	--	--	--	--	--	--	--
8/11/70	--	--	--	--	--	24.5	--	--	--
8/12/70	--	--	--	--	--	--	--	--	--
8/13/70	--	--	--	--	--	11.9	--	--	--
8/14/70	--	--	--	--	--	--	--	--	--
8/15/70	--	--	--	--	--	--	--	--	--
8/16/70	--	--	--	--	--	--	--	--	--
8/17/70	--	--	--	--	--	--	--	--	--
8/18/70	--	--	--	--	--	138.4	--	--	--
8/19/70	--	--	--	--	--	--	--	--	--
8/20/70	--	--	--	--	--	29.1	--	65	--
8/21/70	--	--	--	--	--	--	--	65	--
8/22/70	--	--	--	--	--	--	--	65	--
8/23/70	--	--	--	--	--	--	--	65	--
8/24/70	--	--	--	--	--	--	--	65	--
8/25/70	--	--	--	--	--	--	--	65	--
8/26/70	--	--	--	--	--	--	--	65	--
8/27/70	--	--	--	--	--	--	--	65	--
8/28/70	--	--	--	--	--	--	--	53	--
8/29/70	1000	4.0	--	--	--	--	--	53	--
8/30/70	1200	--	--	--	--	--	--	53	--
8/31/70	--	--	--	--	--	--	--	24	--

TABLE F-2 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
9/1/70	--	--	--	--	--	119.6	--	24	--
9/2/70	--	--	--	--	--	--	--	24	--
9/3/70	900	2.0	--	--	--	149.0	1660	24	--
9/4/70	--	--	--	--	--	--	1627	24	--
9/5/70	--	--	--	--	--	--	1823	24	--
9/6/70	--	--	--	--	--	--	1920	24	--
9/7/70	650	0.2	--	--	--	--	1498	24	--
9/8/70	--	--	--	--	--	238.0	1733	24	--
9/9/70	850	1.5	--	--	--	--	1022	24	--
9/10/70	--	--	--	--	--	--	--	24	--
9/11/70	--	--	--	--	--	--	--	24	--
9/12/70	2200	--	--	--	--	--	--	24	--
9/13/70	--	--	--	--	--	--	--	24	--
9/14/70	--	--	--	--	--	--	--	24	--
9/15/70	40	750	2.5	--	--	325	--	24	--
9/16/70	--	--	--	--	--	--	--	36	--
9/17/70	--	--	--	--	--	--	--	36	--
9/18/70	--	--	--	--	--	--	--	36	--
9/19/70	--	--	--	--	--	--	--	36	--
9/20/70	--	--	--	--	--	--	--	36	--
9/21/70	--	--	--	--	--	--	--	36	--
9/22/70	--	--	--	--	--	--	--	36	--
9/23/70	--	--	--	--	--	--	--	36	--
9/24/70	600	1600	2.3	303	--	--	--	36	--
9/25/70	--	--	--	--	--	723.75	--	16	--
9/26/70	--	--	--	--	--	--	--	16	--
9/27/70	--	--	--	--	--	--	--	16	--
9/28/70	250	1000	3.0	303	--	--	--	16	--
9/29/70	--	--	--	--	--	190	--	16	--
9/30/70	1200	1750	2.5	379	689	--	--	16	--

TABLE 5-3 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
10/1/70	--	--	--	--	--	310	--	16	--
10/2/70	--	--	--	--	--	--	--	16	--
10/3/70	--	--	--	--	--	--	--	16	--
10/4/70	--	--	--	--	--	--	--	16	--
10/5/70	--	--	--	--	--	--	--	16	--
10/6/70	200	1850	1.0	455	--	--	--	16	--
10/7/70	300	2100	4.0	606	--	--	--	16	--
10/8/70	--	--	--	--	--	--	--	16	--
10/9/70	600	1100	3.0	455	--	--	--	16	--
10/10/70	--	--	--	--	--	--	--	16	--
10/11/70	--	--	--	--	--	--	--	16	--
10/12/70	--	--	--	--	--	--	--	16	--
10/13/70	--	--	--	--	--	460.0	--	16	--
10/14/70	--	--	--	--	--	275.0	--	16	--
10/15/70	--	--	--	--	--	--	--	16	--
10/16/70	--	--	--	--	--	--	--	16	--
10/17/70	--	--	--	--	--	--	--	16	--
10/18/70	--	--	--	--	--	--	--	16	--
10/19/70	--	--	--	--	--	--	--	16	--
10/20/70	--	--	--	--	--	--	--	16	--
10/21/70	--	--	--	--	--	--	--	16	--
10/22/70	150	350	3.0	288	485	--	--	16	--
10/23/70	180	660	0.5	334	173	--	--	16	--
10/24/70	--	--	--	--	--	--	--	16	--
10/25/70	--	--	--	--	--	1050	--	16	--
10/26/70	--	--	--	--	--	725	--	Batch	--
10/27/70	150	1500	2	455	--	--	--	Batch	--
10/28/70	--	--	--	--	--	--	--	Batch	--
10/29/70	--	--	--	--	--	--	--	Batch	--
10/30/70	--	--	--	--	--	--	--	2	--
10/31/70	--	--	--	--	--	--	--	2	--

TABLE F-4 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
11/1/70	--	--	--	--	--	--	--	2	--
11/2/70	--	--	--	--	--	--	--	2	--
11/3/70	--	--	--	--	--	368	--	2	--
11/4/70	--	--	--	--	--	--	--	10	--
11/5/70	--	--	--	--	--	--	--	10	--
11/6/70	--	--	--	--	--	--	--	10	--
11/7/70	--	--	--	--	--	--	--	10	--
11/8/70	--	--	--	--	--	--	--	10	--
11/9/70	--	--	--	--	--	--	--	10	--
11/10/70	100	400	0.5	114	173	--	--	--	--
11/11/70	--	--	--	--	--	--	--	--	--
11/12/70	--	--	--	--	--	--	--	--	--
11/13/70	--	--	--	--	--	--	--	--	--
11/14/70	--	--	--	--	--	--	--	--	--
11/15/70	50	90	0.5	76	85	--	--	--	--
11/16/70	60	100	--	61	260	--	--	--	--
11/17/70	10	285	--	98	371	--	--	--	--
11/18/70	10	405	--	129	208	--	--	--	--
11/19/70	--	--	--	--	--	--	--	--	--
11/20/70	10	325	--	106	208	--	--	--	--
11/21/70	--	--	--	--	--	--	--	--	--
11/22/70	--	--	--	--	--	--	--	--	--
11/23/70	--	--	--	--	--	--	--	--	--
11/24/70	--	--	--	--	--	--	--	--	--
11/25/70	--	--	--	--	--	--	--	--	--
11/26/70	--	--	--	--	--	--	--	--	--
11/27/70	--	--	--	--	--	--	--	--	--
11/28/70	--	--	--	--	--	--	--	--	--
11/29/70	--	--	--	--	--	--	--	--	--
11/30/70	10	280	--	99	87	--	--	--	--

TABLE F-5 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
12/1/70	20	58	--	865	290	122	780	--	--
12/2/70	7.2	690	--	--	--	--	--	--	--
12/3/70	10	175	--	137	235	175	1361	--	--
12/4/70	14.4	300	--	75	215	38	889	--	--
12/5/70	9.2	320	--	100	83.5	66	1338	--	--
12/6/70	18.7	475	--	150	835	163	1377	--	--
12/7/70	4.0	475	--	187	446	118	1360	--	--
12/8/70	--	475	--	137	804	--	--	--	--
12/9/70	--	--	--	--	--	--	--	--	--
12/10/70	70	400	--	350	270	--	--	--	--
12/11/70	--	--	--	--	--	--	--	--	--
12/12/70	--	--	--	--	--	--	--	--	--
12/13/70	--	--	--	--	--	--	--	--	--
12/14/70	--	--	--	--	--	--	--	--	--
12/15/70	--	--	--	--	--	--	--	--	--
12/16/70	210	325	--	68.1	601	--	--	--	--
12/17/70	150	450	--	120	546	--	--	--	--
12/18/70	--	--	--	--	--	--	--	--	--
12/19/70	--	--	--	--	--	--	--	--	--
12/20/70	--	--	--	--	--	--	--	--	--
12/21/70	--	--	--	--	--	--	--	--	--
12/22/70	--	--	--	--	--	--	--	--	--
12/23/70	--	--	--	--	--	--	--	--	--
12/24/70	--	--	--	--	--	--	--	--	--
12/25/70	--	--	--	--	--	--	--	--	--
12/26/70	--	--	--	--	--	--	--	--	--
12/27/70	--	--	--	--	--	--	--	--	--
12/28/70	--	--	--	--	--	--	--	--	--
12/29/70	--	--	--	--	--	--	--	--	--
12/30/70	--	--	--	--	--	--	--	--	--
12/31/70	--	--	--	--	--	--	--	--	--

TABLE F-6 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
1/1/71	--	--	--	--	--	--	--	--	--
1/2/71	--	--	--	--	--	--	--	--	--
1/3/71	--	--	--	--	--	--	--	--	--
1/4/71	--	--	--	--	--	--	--	--	--
1/5/71	--	--	--	--	--	--	--	--	--
1/6/71	--	--	--	--	--	--	--	--	--
1/7/71	--	--	--	--	--	--	--	--	--
1/8/71	--	--	--	--	--	--	--	--	1.0
1/9/71	--	--	--	--	--	--	--	--	0.8
1/10/71	--	--	--	--	--	--	--	--	0.6
1/11/71	--	--	--	--	--	--	--	--	0.7
1/12/71	--	--	--	--	--	--	--	--	0.5
1/13/71	50	1200	3.0	180	--	--	--	--	0.4
1/14/71	--	--	--	--	--	--	--	--	0.7
1/15/71	--	--	--	--	--	--	--	--	0.53
1/16/71	75	750	--	200	692	--	--	--	0.51
1/17/71	--	--	--	--	--	--	--	--	0.58
1/18/71	550	1000	--	455	865	76.25	--	--	0.68
1/19/71	--	--	--	--	--	--	--	--	0.69
1/20/71	200	625	--	30	259	168.75	--	--	0.71
1/21/71	--	--	--	--	--	--	--	--	0.86
1/22/71	--	--	--	--	--	--	--	--	0.73
1/23/71	--	--	--	--	--	--	--	--	0.62
1/24/71	600	1000	5.0	454	430	183.7	--	--	0.65
1/25/71	--	--	--	--	--	--	--	--	0.53
1/26/71	--	--	--	--	--	--	--	--	0.89
1/27/71	--	--	--	--	--	--	--	--	0.92
1/28/71	--	--	--	--	--	--	--	--	0.68
1/29/71	--	--	--	--	--	--	--	--	0.65
1/30/71	--	--	--	--	--	--	--	--	0.60
1/31/71	--	--	--	--	--	--	--	--	0.71

TABLE F-7 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
2/1/71	100	95	0.5	61	405	--	--	--	0.82
2/2/71	220	200	0.5	61	208	--	--	--	0.71
2/3/71	80	120	0.5	91	346	--	--	--	0.66
2/4/71	120	290	0.5	91	346	--	--	--	0.99
2/5/71	600	504	0.5	61	2249	--	--	--	0.4
2/6/71	--	--	--	--	--	--	--	--	0.35
2/7/71	1700	40	0.5	30	6574	--	--	--	0.32
2/8/71	--	--	--	--	--	--	--	--	0.45
2/9/71	30	160	0.5	30	--	--	--	--	0.42
2/10/71	10	1400	--	122	--	--	--	--	0.4
2/11/71	--	--	--	--	--	--	--	--	0.32
2/12/71	200	180	0.5	30	--	--	--	--	0.4
2/13/71	120	95	--	91	--	--	--	--	0.5
2/14/71	160	140	1.0	91	--	--	--	--	0.5
2/15/71	--	--	--	--	--	--	--	--	0.4
2/16/71	--	--	--	--	Total	380	--	--	0.4
2/17/71	630	350	2.0	182	952	--	--	--	0.5
2/18/71	150	215	1.0	91	865	--	--	--	0.5
2/19/71	150	175	0.5	61	865	392	--	--	1.01
2/20/71	160	350	0.5	30	830	--	--	--	0.79
2/21/71	--	--	--	--	--	--	--	--	Flood
2/22/71	--	--	--	--	--	--	--	--	--
2/23/71	--	--	--	--	--	--	--	--	--
2/24/71	--	--	--	--	--	--	--	--	--
2/25/71	200	140	0.5	30	1125	1312	--	--	0.5
2/26/71	70	220	0.5	30	208	190	--	--	0.5
2/27/71	--	--	--	--	--	--	--	--	0.5
2/28/71	--	--	--	--	--	--	--	--	0.5

TABLE F-8 RAW DATA - EQUALIZED RAW FEED TO PLANT, PART II

Date	Na_2SO_3 PPM	Na_2SO_4 PPM	Fe PPM	Cl- PPM	Alkalinity PPM	Phenol PPM	TOC PPM	Equalization Time-Hours	Flow MGD
3/1/71	--	--	--	--	--	372	--	--	0.66
3/2/71	--	--	--	--	--	--	--	--	--
3/3/71	--	--	--	--	--	--	--	--	--
3/4/71	--	--	--	--	--	368.7	--	--	0.66
3/5/71	40	600	0.5	114	778	--	--	--	0.46
3/6/71	150	400	0.5	151	1125	--	--	--	0.48
3/7/71	100	625	0.5	650	173	--	--	--	0.45
3/8/71	380	1350	0.5	242	952	--	--	--	0.51
3/9/71	--	--	--	--	--	--	--	--	0.59
3/10/71	220	800	0.5	242	1211	--	--	--	0.39
3/11/71	540	1600	0.5	242	917	--	--	--	0.55
3/12/71	150	425	0.5	303	1073	--	--	--	0.59
3/13/71	--	--	--	--	--	--	--	--	0.61
3/14/71	--	--	--	--	--	--	--	--	0.63
3/15/71	160	170	--	91	346	--	--	--	0.48
3/16/71	50	200	--	61	969	--	--	--	0.45
3/17/71	30	150	--	30	657	--	--	--	0.46
3/18/71	100	20	--	30	415	--	--	--	0.62
3/19/71	30	180	--	61	606	--	--	--	0.47
3/20/71	30	140	--	61	830	--	--	--	0.32
3/21/71	110	130	--	30	986	--	--	--	0.26
3/22/71	100	122	--	122	1660	1563	--	--	0.37
3/23/71	70	675	--	122	1505	492.5	--	--	0.55
3/24/71	80	400	--	61	536	--	--	--	0.62
3/25/71	--	--	--	--	--	--	--	--	0.92
3/26/71	130	380	--	61	1078	--	--	--	0.50
3/27/71	1600	2000	--	333	329	--	--	--	0.44
3/28/71	180	130	--	61	571	--	--	--	0.48
3/29/71	40	300	--	30	336	144.7	--	--	0.55
3/30/71	210	400	--	91	381	--	--	--	0.50
3/31/71	--	--	--	--	--	--	--	--	--

TABLE G-1 OXIDATION TOWER DATA

Date	OXIDATION TOWER FEED COD PPM	BOD PPM	Phenol PPM	Dilution	Recycle	Flow GPM	TOWER EFFLUENT COD PPM	BOD PPM	Phenol PPM	TOWER PERFORMANCE PERCENT REMOVAL COD	BOD	Phenol
9/11/70	2900	799	--	1:1	--	5	2560	832	--	12	0	--
9/12/70	1920	1740	--	1:1	--	5	1960	810	--	0	43	--
9/13/70	--	622	--	1:1	--	5	--	600	--	--	35	--
9/14/70	2065	530	--	1:1	--	5	1585	263	--	23	49	--
9/15/70	2400	810	--	1:1	--	5	2099	930	--	8	-%	--
9/16/70	1880	435	--	1:1	--	5	1678	300	--	11	31	--
9/17/70	1888	440	--	1:1	--	5	1640	360	--	13	18	--
9/18/70	--	--	--	0	--	10	--	--	--	--	--	--
9/19/70	--	--	--	--	--	10	--	--	--	--	--	--
9/20/70	--	--	--	--	--	10	--	--	--	--	--	--
9/21/70	--	--	--	--	--	10	--	--	--	--	--	--
9/22/70	--	--	--	--	--	10	--	--	--	--	--	--
9/23/70	--	--	--	--	--	10	--	--	--	--	--	--
9/24/70	8460	3693	--	0	75%	10	8300	2962	--	2	20	--
9/25/70	8450	3687	723.75	0	75%	10	6910	2843	1165	18	21	--
9/26/70	7090	3513	--	0	75%	10	8020	2730	--	0	22	--
9/27/70	7700	2020	--	0	75%	10	6800	1845	--	117	--	--
9/28/70	5300	2813	--	0	75%	10	6700	2640	--	0	--	--
9/29/70	4390	--	190	0	75%	10	5410	2020	375	0	--	--
9/30/70	8850	4935	--	0	75%	10	6670	2053	--	--	--	--

TABLE G-2 OXIDATION TOWER DATA

	OXIDATION TOWER FEED						TOWER EFFLUENT			TOWER PERFORMANCE PERCENT REMOVAL		
Date	COD PPM	BOD PPM	Phenol PPM	Dilution	Recycle	Flow GPM	COD PPM	BOD PPM	Phenol PPM	COD	BOD	Phenol
10/1/70	6205	2439	310	0	75%	10	9297	3213	420	0	--	--
10/2/70	--	--	--	2:1	95%	10	--	--	--	--	--	--
10/3/70	--	--	--	2:1	95%	10	--	--	--	--	--	--
10/4/70	--	--	--	2:1	95%	10	--	--	--	--	--	--
10/5/70	--	--	--	2:1	95%	10	--	--	--	--	--	--
10/6/70	--	--	--	2:1	95%	10	--	--	--	--	--	--
10/7/70	3722	1700	--	2:1	75%	10	3610	1690	--	3	3	--
10/8/70	--	2017	--	2:1	75%	10	--	1864	--	--	7.5	--
10/9/70	2840	1185	--	2:1	75%	10	2850	1500	--	0	0	--
10/10/70	2020	889	--	2:1	75%	10	2028	727	--	0	18	--
10/11/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/12/70	1640	557	--	2:1	75%	10	1445	656	--	12	0	--
10/13/70	1882	652	--	2:1	75%	10	1802	596	--	4	8.5	--
10/14/70	1510	615	--	2:1	75%	10	1320	602	--	12	2.5	
10/15/70	1265	570	--	2:1	75%	10	1165	375	--	8	34	--
10/16/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/17/70	1100	--	--	2:1	75%	10	1055	--	--	4	--	--
10/18/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/19/70	--	517	--	2:1	75%	10	--	378	--	--	27	--
10/20/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/21/70	--	--	--	3:1	75%	10	--	--	--	--	--	--
10/22/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/23/70	1938	--	--	2:1	75%	10	1780	--	--	8	--	--
10/24/70	1948	--	--	2:1	75%	10	1962	--	--	0	--	--
10/25/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/26/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/27/70	1685	--	--	2:1	75%	10	1585	--	--	6	--	--
10/28/70	2582	--	--	2:1	75%	10	1770	--	--	31	--	--
10/29/70	--	--	--	2:1	75%	10	--	--	--	--	--	--
10/30/70	1140	1140	--	2:1	75%	10	960	960	--	15	15	--
10/31/70	--	--	--	2:1	75%	10	--	--	--	--	--	--

TABLE G-3 OXIDATION TOWER DATA

	OXIDATION TOWER FEED						TOWER EFFLUENT			TOWER PERFORMANCE PERCENT REMOVAL		
Date	COD PPM	BOD PPM	Phenol PPM	Dilution	Recycle	Flow GPM	COD PPM	BOD PPM	Phenol PPM	COD	BOD	Phenol
11/1/70	--	2335	--	2:1	75%	10	--	2280	--	--	2	--
11/2/70	1600	720	--	2:1	75%	10	1600	690	--	--	4.0	--
11/3/70	1860	600	--	2:1	75%	10	1490	300	68.0	20	50	--
11/4/70	1420	420	--	2:1	75%	10	1360	375	--	4.0	10	--
11/5/70	1730	--	--	2:1	75%	10	1600	--	--	7.5	--	--
11/6/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/7/70	1960	200	--	none	75%	10	2010	915	--	0	0	--
11/8/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/9/70	1500	638	--	none	75%	10	1290	645	--	14	0	--
11/10/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/11/70	2200	--	--	none	75%	10	2260	--	--	22	--	--
11/12/70	2540	--	--	none	75%	10	2560	--	--	0	--	--
11/13/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/14/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/15/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/16/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/17/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/18/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/19/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/20/70	--	--	--	none	75%	10	--	--	--	--	--	--
11/21/70	--	--	--	none	75%	10	--	--	--	--	--	--

APPENDIX B

SIX MONTHS OPERATIONAL DATA

FOR ACTIVATED CARBON WASTE TREATING PLANT

PARSHALL FLUME WASTE DATA FOR SEPTEMBER 1973

	BOD		COD		Phenol		SS	
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM
1	3997	1052	13137	3457	759	200	763	201
2	1401	1078	4843	3725	285	219	351	270
3	1401	1078	4843	3725	285	219	351	270
4	No Analysis							
5	3086	1029	8092	2693	660	220	361	120
6	3192	887	8004	2223	731	203	314	87
7	4624	872	12866	2428	1176	222	232	44
8	3379	1024	7747	2348	609	185	159	48
9	4105	955	9629	2239	815	190	365	85
10	3488	811	12555	2920	579	135	592	138
11	4410	1131	9547	2448	548	141	203	52
12	3935	984	9005	2251	843	211	522	131
13	3293	941	7929	2265	642	183	340	97
14	3410	874	8123	2083	758	194	393	101
15	3102	776	9546	2387	543	136	487	122
16	1216	811	2956	1970	323	215	180	120
17	2170	804	4982	1845	602	223	24	9
18	3614	927	9868	2530	676	173	430	110
19	3725	1552	7050	2938	464	193	233	97
20	3035	1265	6096	2540	455	190	211	88
21	4625	1186	9951	2552	677	174	372	95
22	3249	792	8419	2053	795	193	367	90
23	2690	769	6755	1930	591	169	464	133
24	2536	725	7576	2165	621	177	428	122
25	4220	917	12577	2734	795	173	542	118
26	5067	1236	13295	3243	937	229	399	97
27	5379	1280	12317	2933	778	185	627	149
28	5757	1175	12791	2610	854	174	656	134
29	3012	913	7372	2234	533	162	833	252
30	2781	732	3659	963	438	115	549	144

PARSHALL FLUME WASTE DATA FOR OCTOBER 1973

Day	BOD		COD		Phenol		SS	
	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM
1	1090	474	1971	857	274	119	269	117
2	287	574	865	173	45	90	63	126
3	Down							
4	342	412	1400	1687	138	166	108	130
5	Down							
6	Down							
7	981	545	3284	1824	303	168	205	114
8	1065	410	3584	1378	433	167	237	91
9	2090	523	8140	2035	485	121	464	116
10	3164	646	9976	2036	703	143	589	120
11	3266	680	9132	1903	691	144	501	104
12	3234	703	9070	1972	568	123	446	97
13	3454	751	9033	1964	647	141	467	102
14	3426	745	6760	1470	478	104	806	175
15	2280	814	6592	2354	557	199	423	151
16	1922	712	6904	2557	358	133	358	133
17	1947	927	5396	2570	341	162	270	129
18	2786	1266	6485	2948	217	99	211	96
19	4036	1062	10974	2888	266	70	707	186
20	----	----	1885	2513	60	80	156	208
21	----	----	3720	3444	194	180	192	177
22	----	----	3182	3458	348	378	170	184
23	2346	978	7718	3216	670	279	323	135
24	3796	791	8740	1820	1518	316	573	119
25	6034	1371	15553	3535	1212	275	551	125
26	5787	1286	16277	3617	1121	249	543	121
27	3433	981	11231	3209	825	236	439	125
28	4053	1228	7760	2352	686	208	502	152
29	8776	1721	14590	2860	1270	249	620	122
30	3494	852	14123	3445	709	173	472	115
31	3618	882	12541	3059	657	160	311	76

PARSHALL FLUME WASTE DATA FOR NOVEMBER 1973

Day	BOD		COD		Phenol		SS	
	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM
1	4212	1359	11552	3726	536	173	356	115
2	6820	1749	18638	4779	934	239	539	138
3	5094	1544	15935	4829	868	263	464	141
4	3655	988	14305	3866	746	202	819	221
5	1546	336	18987	4128	1116	243	804	175
6	2432	811	13150	438	637	212	403	134
7	2196	784	12236	4370	615	220	419	150
8	833	1111	2557	3409	159	212	134	179
9	1049	456	6388	2777	472	205	461	200
10	1597	532	7858	2619	375	125	633	211
11	3188	778	12587	3070	614	150	901	220
12	3493	944	9517	2572	643	174	1133	306
13	3239	1157	8289	2960	448	160	729	260
14	8069	1921	14924	3553	582	139	923	220
15	3730	1166	11101	3469	605	189	889	278
16	3836	1009	11558	3042	881	232	732	193
17	5393	1124	14220	2963	782	163	1089	227
18	4778	853	15630	2791	724	129	1447	258
19	10040	1673	17183	2864	1340	223	1394	232
20	4375	994	13184	2996	667	152	1228	279
21	5633	1174	14580	3038	660	138	105	22
22	4984	1246	10957	2739	520	130	408	102
23	6286	998	16887	2680	749	119	1193	189
24	4379	876	13037	2607	547	109	706	141
25	5359	940	12772	2241	536	94	706	124
26	7093	1163	13057	2140	786	129	804	132
27	4644	876	13457	2539	775	146	721	136
28	3991	868	10423	2266	852	185	65	14
29	5037	916	13395	2435	1386	252	821	149
30	7006	1208	18098	3120	1115	192	616	106

PARSHALL FLUME WASTE DATA FOR DECEMBER 1973

	BOD		COD		Phenol		SS	
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM
1	5648	1225	14778	3284	1202	267	557	124
2	5703	1462	9830	2521	800	205	515	132
3	3755	939	10945	2736	861	215	532	133
4	4484	1043	13817	3213	932	217	659	153
5	4979	1158	13817	3213	997	232	529	123
6	4987	924	14402	2667	1076	199	721	134
7	4926	896	14146	2572	925	168	765	139
8	3545	622	13991	2455	1418	249	641	112
9	4343	736	11871	2012	765	130	718	122
10	3982	766	9235	1776	869	167	889	171
11	3593	719	8676	1735	879	176	889	178
12	2819	626	9367	1734	1003	186	770	143
13	3318	583	10616	1862	476	84	754	132
14	3440	529	9776	1504	633	97	672	103
15	3817	516	9800	1324	397	54	1605	217
16	3693	671	8224	1495	633	115	672	122
17	5300	1000	10366	1956	614	116	592	112
18	5847	1218	10821	2254	591	123	558	116
19	6080	1216	15422	3084	1249	250	530	106
20	7834	1632	13251	2761	1022	213	580	121
21	7611	1770	9573	2226	1027	239	546	127
22	6223	1447	11392	2649	1578	367	775	180
23	2418	1051	5477	2381	748	325	259	113
24	2058	895	4196	1824	621	270	208	90
25	3730	704	7089	1338	812	153	665	125
26	Down							
27	Down							
28	Down							
29	Down							
30	Down							
31	Down							

PARSHALL FLUME WASTE DATA FOR JANUARY 1974

	BOD		COD		Phenol		SS	
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM
1	Down							
2	1959	435	6297	1399	474	105	551	122
3	3156	535	8575	1453	831	141	855	145
4	4950	811	8501	1394	943	154	913	150
5	3678	694	10716	2021	784	148	661	125
6	4414	833	9024	1703	1312	248	698	132
7	4527	838	8216	1521	1247	231	602	111
8	4496	848	5590	1055	1315	248	515	97
9	6489	1224	9900	1868	1031	195	836	158
10	4113	823	8862	1772	886	177	666	133
11	3541	600	8655	1467	708	120	767	130
12	4263	761	7117	1271	816	146	698	124
13	3816	720	5971	1127	993	187	440	83
14	3459	721	7631	1590	780	163	428	89
15	2421	673	6466	1796	674	187	394	109
16	297	358	1525	1837	152	183	90	108
17	3578	663	10182	1886	784	145	417	77
18	1962	417	7872	1675	871	185	508	108
19	3336	629	7468	1409	858	162	432	82
20	3213	656	4330	884	495	101	406	83
21	1406	270	5389	1036	642	123	467	90
22	3984	711	7877	1407	666	119	416	74
23	4129	724	9692	1700	680	119	447	78
24	4168	731	9642	1692	770	135	468	82
25	3485	658	7943	1499	769	145	361	68
26	2116	432	5971	1219	520	106	570	116
27	2216	481	5148	1119	397	86	310	67
28	2399	436	6220	1131	800	145	507	92
29	2962	581	7445	1460	613	120	449	88
30	2924	650	8812	1958	567	126	412	92
31	420	117	2288	636	---	---	---	--

PARSHALL FLUME WASTE DATA FOR FEBRUARY 1974

	BOD		COD		Phenol		SS	
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM
1	Down							
2	1049	699	3059	2039	277	185	162	108
3	2820	588	9013	1878	737	154	295	61
4	3900	886	5341	1214	631	143	396	90
5	1465	357	7059	1722	539	131	320	78
6	3116	611	8577	1682	872	170	374	73
7	4292	842	8032	1575	775	152	429	84
8	4565	830	11296	2054	866	157	425	77
9	3686	819	9777	2173	366	81	338	75
10	3561	712	9147	1829	712	142	382	76
11	2784	557	10377	2075	829	166	366	73
12	4446	1170	9519	2505	470	124	270	71
13	4178	1161	12896	3582	475	132	322	89
14	4812	1337	8580	2383	474	132	295	82
15	4880	957	9678	1898	754	148	608	119
16	5283	978	9667	1790	767	142	537	99
17	4466	971	8985	1953	898	195	548	119
18	1844	401	9081	1974	1149	250	662	144
19	4596	867	12838	2422	1408	266	710	133
20	4595	884	21740	4181	1479	284	644	124
21	4697	903	19371	3725	1222	235	577	111
22	4138	962	16309	3793	736	171	342	79
23	4156	1154	5407	1502	680	189	552	153
24	2166	677	4428	1384	558	174	397	124
25	3176	774	11392	2779	768	187	556	136
26	3307	827	10939	2735	785	196	380	95
27	4041	918	11124	2528	681	155	554	126
28	3035	723	10125	2411	465	111	710	169

TREATED WASTE DATA FOR SEPTEMBER 1973

	BOD		COD		Phenol		SS		Flow
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	MGPD
1	1388	323	2550	593	32.0	7.0	148	34	0.52
2	Down, Effluent Held in Retention Pond								
3	Down, Effluent Held in Retention Pond								
4	Down, Effluent Held in Retention Pond								
5	791	360	890	405	5.4	2.5	43	20	0.26
6	610	210	1074	370	9.3	3.2	314	108	0.35
7	803	223	1974	548	12.9	3.6	232	64	0.43
8	1269	264	2057	429	11.0	2.3	159	33	0.57
9	1289	263	1907	389	1.0	0.2	365	74	0.59
10	1015	236	1984	461	0.9	0.2	592	138	0.52
11	1154	262	2169	493	0.6	0.1	203	46	0.53
12	1043	237	2689	611	1.3	0.3	522	119	0.53
13	772	188	1352	330	0.5	0.1	115	28	0.49
14	1196	244	1723	352	0.7	0.1	64	13	0.59
15	733	170	1407	327	0.9	0.2	159	37	0.52
16	---	---	----	---	---	---	---	---	---
17	453	302	728	485	0.4	0.3	153	102	0.18
18	1399	318	2526	572	2.4	0.6	145	33	0.53
19	1779	539	2628	796	0.6	0.2	58	18	0.39
20	1208	417	2325	802	0.6	0.2	53	18	0.35
21	1865	434	2971	691	0.8	0.2	86	20	0.52
22	1299	295	2177	495	0.9	0.2	502	114	0.53
23	1124	274	1717	419	0.5	0.1	142	35	0.49
24	1079	263	2029	495	1.2	0.3	285	70	0.49
25	1402	286	2183	446	0.7	0.1	158	32	0.59
26	1233	262	2033	433	1.2	0.3	160	34	0.56
27	1445	314	2196	477	0.7	0.2	101	22	0.55
28	1810	402	2693	598	0.7	0.2	113	25	0.54
29	1554	345	2533	563	2.0	0.4	358	80	0.54
30	790	239	1146	347	1.0	0.3	106	32	0.39

TREATED WASTE DATA FOR OCTOBER 1973

	BOD		COD		Phenol		SS		Flow
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	MGPD
1	116	116	358	358	0.2	0.2	24	24	0.12
2	Down, Effluent Held in Retention Pond								
3	Down, Effluent Held in Retention Pond								
4	Down, Effluent Held in Retention Pond								
5	Down, Effluent Held in Retention Pond								
6	Down, Effluent Held in Retention Pond								
7	Down, Effluent Held in Retention Pond								
8	84	76	609	554	0.1	0.1	13	12	0.13
9	383	79	1043	222	0.6	0.1	89	19	0.56
10	548	105	1147	221	0.7	0.1	62	12	0.62
11	666	131	1070	210	0.8	0.2	86	17	0.61
12	741	148	1164	233	3.1	0.6	75	15	0.60
13	901	180	1406	281	3.7	0.7	85	17	0.60
14	686	208	976	296	0.3	0.1	49	15	0.39
15	537	185	482	166	0.3	0.1	53	18	0.35
16	483	167	765	264	0.4	0.1	32	11	0.35
17	766	255	1670	557	1.8	0.6	71	24	0.36
18	771	266	1193	411	3.1	1.1	50	17	0.35
19	1297	288	2347	522	5.4	1.2	296	66	0.54
20	----	---	----	---	---	---	---	--	----
21	----	---	----	---	---	---	---	--	----
22	----	---	----	---	---	---	---	--	----
23	400	235	663	390	0.4	0.2	181	106	0.20
24	1039	236	2427	552	7.5	1.7	277	63	0.53
25	1331	283	2059	438	0.7	0.2	88	19	0.56
26	1166	324	2246	624	1.3	0.4	43	12	0.43
27	1022	284	2173	604	3.6	1.0	54	15	0.43
28	940	313	1523	508	3.9	1.3	36	12	0.36
29	698	268	1254	482	1.0	0.4	56	22	0.31
30	873	218	1856	464	1.2	0.3	124	31	0.48
31	884	268	1761	534	0.8	0.2	74	22	0.40

TREATED WASTE DATA FOR NOVEMBER 1973

Day	BOD Lbs/Day	BOD PPM	COD Lbs/Day	COD PPM	Phenol Lbs/Day	Phenol PPM	SS Lbs/Day	SS PPM	Flow MGPD
1	1198	399	2756	919	1.3	0.4	77	26	0.36
2	972	335	2206	761	0.3	0.1	98	34	0.35
3	1256	380	2223	674	0.9	0.3	221	67	0.39
4	1173	335	2625	750	1.1	0.3	99	28	0.42
5	783	230	2519	741	0.7	0.2	122	36	0.41
6	1001	313	2323	726	0.4	0.1	88	28	0.38
7	277	231	1014	845	0.6	0.5	25	21	0.14
8	1086	350	2591	836	2.2	0.7	87	28	0.37
9	881	267	2169	657	2.1	0.6	98	30	0.39
10	940	276	2275	669	0.7	0.2	92	27	0.41
11	1316	286	2417	525	0.7	0.2	115	25	0.55
12	1238	302	1792	437	3.3	0.8	176	43	0.49
13	881	267	1686	511	0.5	0.2	84	25	0.39
14	1816	356	2658	521	1.4	0.3	164	32	0.61
15	1494	393	2193	577	0.3	0.1	121	32	0.45
16	1082	277	1893	485	1.1	0.3	95	24	0.47
17	1404	305	2115	460	1.8	0.4	125	27	0.55
18	1771	361	2369	483	0.5	0.1	74	15	0.59
19	1934	411	2505	533	0.9	0.2	84	18	0.56
20	1655	394	2500	595	0.4	0.1	129	31	0.50
21	2233	519	3315	771	0.4	0.1	115	27	0.51
22	1117	399	2523	901	0.3	0.1	195	70	0.34
23	1086	329	2261	685	0.5	0.2	130	39	0.39
24	1377	383	2456	682	0.5	0.1	152	42	0.43
25	1321	400	2046	620	0.5	0.2	63	19	0.40
26	1376	353	1950	500	0.8	0.2	150	38	0.47
27	2160	514	2578	614	0.5	0.1	121	29	0.50
28	1366	310	1989	452	0.4	0.1	75	17	0.53
29	1474	335	2384	542	0.8	0.2	93	21	0.62
30	1744	396	2523	573	0.4	0.1	21	5	0.63

TREATED WASTE DATA FOR DECEMBER 1973

	BOD		COD		Phenol		SS		Flow
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	MGPD
1	1645	484	2602	765	1.3	0.4	21	6	0.41
2	1250	357	2213	632	1.0	0.3	60	17	0.42
3	1420	394	2299	639	0.5	0.1	78	22	0.43
4	1223	314	2375	609	0.5	0.1	82	21	0.47
5	905	232	1884	483	0.6	0.2	74	19	0.47
6	1211	242	2312	462	2.4	0.5	95	19	0.60
7	1297	254	2350	460	6.9	1.4	107	21	0.61
8	1019	192	2159	407	5.5	1.0	115	22	0.63
9	1065	205	1828	352	1.5	0.3	98	19	0.62
10	927	193	1548	323	0.7	0.4	95	18	0.57
11	822	171	1415	295	0.8	0.2	109	23	0.57
12	761	152	1562	312	1.0	0.2	105	21	0.60
13	993	187	1860	351	0.5	0.1	102	19	0.63
14	1170	229	1671	328	1.4	0.3	142	28	0.61
15	1250	236	1771	334	2.4	0.5	236	45	0.63
16	1323	259	1836	360	0.8	0.2	87	17	0.61
17	1265	258	1815	370	0.7	0.1	118	24	0.59
18	1238	263	1703	362	0.5	0.1	111	24	0.56
19	1294	264	2193	448	1.0	0.2	83	17	0.59
20	1700	362	2131	453	1.0	0.2	51	11	0.56
21	1527	355	1913	445	0.5	0.1	145	38	0.51
22	1551	369	2304	549	2.3	0.5	124	30	0.50
23	742	353	1224	583	0.7	0.3	38	18	0.25
24	563	268	1033	492	0.5	0.3	59	28	0.25
25	1019	485	1941	924	0.3	0.1	365	174	0.62
26	Down, Effluent Held in Retention Pond								
27	Down, Effluent Held in Retention Pond								
28	Down, Effluent Held in Retention Pond								
29	Down, Effluent Held in Retention Pond								
30	Down, Effluent Held in Retention Pond								
31	Down, Effluent Held in Retention Pond								

TREATED WASTE DATA FOR JANUARY 1974

	BOD		COD		Phenol		SS		Flow
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	MGPD
1	Down, Effluent Held in Retention Pond								
2	561	128	1167	265	0.6	0.1	47	11	0.53
3	753	130	993	171	0.7	0.1	65	11	0.70
4	1357	226	1754	292	0.7	0.1	90	15	0.72
5	1034	199	1683	324	0.7	0.1	68	13	0.62
6	824	162	1177	231	0.5	0.1	91	18	0.61
7	1035	195	1344	254	0.6	0.1	16	3	0.64
8	1295	249	1357	261	1.3	0.2	57	11	0.62
9	1448	278	1998	384	1.3	0.3	78	15	0.62
10	1023	209	1241	253	1.9	0.4	93	19	0.59
11	1436	248	1995	344	3.1	0.5	203	35	0.70
12	1607	292	2459	447	7.2	1.3	155	28	0.66
13	1261	243	1916	368	9.7	1.9	95	18	0.63
14	960	200	1639	341	6.7	1.4	105	22	0.57
15	585	172	1010	297	10.9	3.2	97	29	0.41
16	152	203	291	388	1.4	1.9	7	9	0.09
17	1062	200	1827	345	1.9	0.4	42	8	0.64
18	899	195	1479	322	9.0	1.9	46	10	0.55
19	982	189	1507	290	1.4	0.3	83	16	0.62
20	842	175	1130	235	2.4	0.5	87	18	0.58
21	701	140	1173	235	2.1	0.4	55	11	0.60
22	835	155	1428	264	1.1	0.2	61	11	0.65
23	983	176	1675	299	2.1	0.4	122	22	0.67
24	1006	180	1524	272	1.7	0.3	67	12	0.67
25	791	152	1718	330	11.2	2.2	130	25	0.62
26	495	103	1039	216	3.7	0.8	92	19	0.58
27	487	108	955	212	1.3	0.3	40	9	0.54
28	558	103	1105	204	1.1	0.2	81	15	0.65
29	841	168	1316	263	0.8	0.2	105	21	0.60
30	988	225	1551	353	1.0	0.2	84	19	0.53
31	770	214	1793	498	0.7	0.2	213	59	0.36

TREATED WASTE DATA FOR FEBRUARY 1974

	BOD		COD		Phenol		SS		Flow
Day	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	Lbs/Day	PPM	MGPD
1	Down, Held in Retention Pond								
2	194	139	354	253	2.4	1.7	27	19	0.17
3	1355	288	1946	414	1.2	0.3	84	18	0.56
4	1070	243	1327	302	1.1	0.3	145	33	0.53
5	668	163	1061	259	0.9	0.2	69	17	0.49
6	932	183	1487	292	1.2	0.2	112	22	0.61
7	1084	213	1773	348	0.5	0.1	61	12	0.61
8	1454	264	1119	203	4.8	0.9	159	29	0.66
9	711	158	980	217	1.9	0.4	72	16	0.54
10	1288	257	1940	388	1.1	0.2	85	17	0.60
11	1060	212	1794	359	2.9	0.6	105	21	0.60
12	1103	290	1634	430	0.8	0.2	69	18	0.46
13	1330	369	2368	658	1.0	0.3	60	17	0.43
14	1167	324	1667	463	1.2	0.3	78	22	0.43
15	1336	262	1896	372	6.4	1.3	31	6	0.61
16	1436	266	2001	371	1.8	0.3	118	22	0.65
17	916	199	1453	316	1.2	0.3	74	16	0.55
18	541	118	1814	394	1.9	0.4	116	25	0.55
19	836	158	2572	485	4.0	0.8	91	17	0.64
20	1197	230	2539	488	5.7	1.1	150	29	0.62
21	1219	239	1949	382	2.8	0.6	128	25	0.61
22	1104	256	1592	370	1.6	0.4	34	8	0.51
23	1070	297	1227	340	4.1	1.2	0	0	0.43
24	679	212	735	229	0.8	0.3	63	20	0.38
25	924	225	1349	329	0.6	0.1	57	14	0.49
26	1117	279	1186	296	1.4	0.4	48	12	0.48
27	1181	268	1479	336	0.7	0.2	36	8	0.53
28	997	237	1358	323	0.0	0.0	80	19	0.50